Sport Fishery Abstracts

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Sport Fishery Abstracts

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Sport Fishery Abstracts is intended to furnish fishery biologists in government agencies and educational institutions with abstracts of the current literature in sport fishery research and management. Abstracts of papers on limnology, ecology, natural history and other fields of specialization will be included when the subject has application to the conservation of sport fish and the restoration of sport fishing.

The symbol (A) following an abstract indicates an author's abstract. Other initials following the abstract are those of abstractors whose names are listed on page ii. If no symbol is given the abstract was prepared by the Editorial staff. The abstracts are numbered serially through the four numbers of each volume. The numbers will be issued irregularly, with a limit of four per year. Each number contains separate Author and Subject indexes.

The first number of each volume contains a list of publications regularly reviewed for suitable abstracts. The succeeding numbers contain any additional publications covered. Suggestions for additional material are solicited in order to obtain as wide a coverage as possible.

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Robert M. Rutherford, Chief
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- * American Midland Naturalist
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U. S. Public Health Service--
Public Health Reports

Others--
American Museum of Natural History Bulletin
Carnegie Museum Annals
Reports of the International Fisheries Commission

*The asterisk indicates this publication was reviewed for this volume of the Abstracts. Others listed will be reviewed in forthcoming issues. Anyone knowing of a source omitted from this list should advise the Editor so that as complete a coverage as possible may be had.

1. Scattergood, Leslie W. 1954. BIBLIOGRAPHIC SOURCES FOR FISHERY STUDENTS AND BIOLOGISTS. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 20-37.

This paper contains lists of journals, compendia bibliographies, and indexes on fisheries and allied subjects.

2. Brown, C. J. D. and Richard J. Graham. 1954. OBSERVATIONS ON THE LONGNOSE SUCKER IN YELLOWSTONE LAKE. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 38-46.

An investigation was made of the food, spawning runs, age and growth, and distribution of the longnose sucker Catostomus catostomus in Yellowstone Lake during the summers of 1951 and 1952. This fish was probably accidentally introduced into Yellowstone Lake by bait fishermen in the early thirties. As many as 2,000 specimens were observed with the annual cutthroat-trout runs in Pelican Creek during the early forties. A total of 1,150 was counted there in 1951. The food of suckers captured in the mouths of tributary streams showed an incidence of 69 percent algae, 40 percent higher aquatic plants, and numerous aquatic insects, particularly Diptera. During the spawning run the largest number of suckers entered the traps on the days when water temperatures were highest. Females were significantly larger than males. The average time spawning fish stayed in Pelican Creek was 19 days for females and 17 days for males. The average loss of weight for spawning females was 4.7 ounces and for males 1.8 ounces. A sample of sucker fry captured on July 9 averaged 13 millimeters in total length. Young taken October 11 averaged 30.5 millimeters. The calculated total lengths for each year of life based on 525 specimens were as follows: first year—2.0 inches; second—4.8; third—8.5; fourth—11.7; fifth—13.6; sixth—15.8; seventh—17.4; eighth—18.1. Females grew more rapidly than the males and reached a larger size. Tagging experiments showed that suckers have a rather restricted range and are frequently taken by pelicans. (A)

3. Swingle, H. S. 1954. FISH POPULATIONS IN ALABAMA RIVERS AND IMPOUNDMENTS. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 47-57.

Fish populations in large Alabama rivers and large impoundments were sampled by using emulsifiable rotenone at a concentration of 1 p. p. m. which is applied to measured areas with pumps and hose. Large channel, blue, and flathead catfishes appeared to be the principal piscivorous species in rivers. The ratios of the weight of forage fish to piscivorous fish and the percentages by weight of harvestable fish in the entire populations appeared similar to those in pond fish populations. The change of environment following impoundment of rivers caused large changes in the species composition of the stock. Pollution of rivers produced changes from balanced to unbalanced fish populations. In one river a polluted area had a smaller standing crop than did an unpolluted portion of the same river, while in another, the polluted area had the larger stock. (A)

4. Sprugel, George Jr. 1954. GROWTH OF BLUEGILLS IN A NEW LAKE, WITH PARTICULAR REFERENCE TO FALSE ANNULI. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 58-75.

McFarland Pond was constructed in 1946 and stocked with 23 2-year-old bluegills (Lepomis macrochirus) in 1947. Scales from the 1947 to 1949 year classes of bluegills were studied with particular attention to the recognition of false and true annuli. No consistent changes in coefficient of condition, K, were noted except for a tendency for the K value to increase with increase in length of fish. Annulus formation occurred from mid-February to mid-June, with most fish forming annuli in the last half of May or early June. Although the body-scale relationship is better described by a third-degree equation, calculated lengths based upon a straightline relationship were nearly as accurate. The brood stock grew rapidly when first placed in the lake. The 1947 year class grew less in 1947 than did the 1948 and 1949 young of the year during their first summers. Late spawning was probably the cause of the poor growth in 1947. By 1949, the bluegills were severely stunted and showed little growth after they reached 1 year of age. Most of the season's growth was completed by early July. The faster growing individuals disappeared before their third year. Male bluegills showed more rapid growth than females after the first year of life. About 90 percent of the 1948 and 1949 year class bluegills showed checks on their scales before the first annulus whereas only 10 percent of the 1947 year class bluegills showed such false marks. False marks after the first annulus seem to be connected with sexual activity. Suggestions are given for recognizing false annuli. (A)

5. Benson, Norman G. 1954. SEASONAL FLUCTUATIONS IN THE FEEDING OF BROOK TROUT IN THE PIGEON RIVER, MICHIGAN. Trans. Am. Fish Soc., Vol. 83 (1953), pp. 76-83.

Stomach contents were analyzed for 420 specimens of wild brook trout (Salvelinus fontinalis) from the Pigeon River, Otsego County, Michigan. All fish were caught by anglers and checked by trained personnel from April 26 to September 14, 1952. Data on coefficient of condition and volume of stomach contents were averaged by 2-week periods. Both condition and volume of stomach contents were highest in May and June and decreased thereafter during the angling season. The data suggested a close relationship among periodicity of growth, condition, and mean volume of stomach contents.

The most common organisms eaten by brook trout during the period of most rapid growth and best condition were mayflies, caddisflies and crayfish. Stream temperatures were 55° to 66° F. when the trout were in the best condition and had the greatest volume of food in their stomachs. Both laboratory and field studies have shown this temperature range to be optimum for feeding and

activity of brook trout. It is suggested, therefore, that growth rate depends upon optimum temperatures and on the abundance of food during the period of optimum temperatures. (A)

6. Haley, A. James. 1954. MICROSPORIDIAN PARASITE, GLUGEA HERTWIGI, IN AMERICAN SMELT FROM THE GREAT BAY REGION, NEW HAMPSHIRE. Trans. Am. Fish. Soc., Vol. 83, (1953), pp. 84-90.

Examination of 1,323 American smelt, Osmerus mordax (Mitchill), from the Great Bay region of New Hampshire during the period from October 1951 through April 1952 showed that 308 (23.3 percent) were infected with Glugea hertwigi. The serious pathological manifestations of the disease suggested that it is an important contributing factor to the recent decline in the smelt population of the area. Although the mode of transmission of the parasite from smelt to smelt is not known, it seems probable that it enters with the food—perhaps after prior mechanical concentration of the spores by one or more of the organisms utilized by the smelt for food. Additional study is needed on the problem of transmission. (A)

7. Alvord, William. 1954. VALIDITY OF AGE DETERMINATIONS FROM SCALES OF BROWN TROUT, RAINBOW TROUT, AND BROOK TROUT. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 91-103.

A total of 1,055 scale samples from tagged recaptured brown trout, rainbow trout, and brook trout and 129 scale samples from planted, marked rainbow trout were taken from Prickley Pear Creek Montana, between June 1949 and October 1951. In addition, scale samples were obtained from 69 rainbow trout planted as fry in Savage Lake, Montana, and from 42 known-age rainbow trout of the brood stock at the U. S. Fish and Wildlife Service Fish Hatchery, Ennis, Montana. Studies of these scales substantiated the general validity of the scale method of aging wild trout and trout planted as fry or young-of-the-year fingerlings.

Recaptured brown trout whose growth rate and annulus formation between growing seasons could be determined totaled 233; of these, 46 failed to form the expected annuli. Of 70 recaptured rainbow trout, 8 failed to form annuli, and of 3 brook trout, 1 failed to form an annulus. Most fish that failed to form annuli were more than 3 years old and had made little or no increase in body length.

Scales from rainbow trout brood stock of known age had "annuli" in varying numbers and positions on fish of the same age. These check marks did not conform to the known age of the trout and were probably caused by hatchery feeding practices and by handling during spawning operations.

Annuli beyond the third were, in general, in close proximity to one another and were difficult to detect. In some older fish, erosion or resorption obliterated scale characters. (A)

8. Saila, Saul B. 1954. BIO-ASSAY PROCEDURES FOR THE EVALUATION OF FISH TOXICANTS WITH PARTICULAR REFERENCE TO ROTENONE. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 104-114.

The effects of variations in volume of solution of toxicant, aggregation, temperature, and change in condition of test animals during time of holding in the laboratory were investigated with regard to possible influences on bio-assay results. The western gambusia, Gambusia affinis affinis (Baird and Girard) was used as the test animal. In spite of relatively favorable experimental conditions, it seems that estimates of relative toxicity are affected by uncontrolled variations which greatly limit dependability.

The relative stability of toxicity indices based on simultaneous comparisons of a standard with test materials was demonstrated. Although the advantages and possible limitations of the toxicity index were not fully explored, the procedure appeared to produce a consistency of results not previously encountered. Factors which may affect toxicity index values remain to be evaluated in bio-assay procedures with fish. However, some indication has already been given of the usefulness of this concept. (A)

9. Greenbank, John. 1954. DEPLORABLE PRESENTATION OF RESULTS OF FISHERY RESEARCH Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 115-119.

A large proportion of the current fishery research literature is cluttered with superfluous mathematical material, such as numbers expressed in too many significant digits or decimal places, data written more precisely than is justified by the experimental procedure, or complicated formulae and equations. This criticism applies particularly to papers published in the Transactions of the American Fisheries Society, a professedly practical journal. Much of this redundant matter could be omitted, with no appreciable loss in clarity or meaning; however, cases vary, and it is impossible to set any hard and fast standards of form. (A)

10. Miller, Richard B. 1954. COMPARATIVE SURVIVAL OF WILD AND HATCHERY-REARED CUTTHROAT TROUT IN A STREAM. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 120-130.

Gorge Creek, a typical small mountain trout stream on the eastern slope of the Rocky Mountains, was used in a test to measure survival and weight changes in hatchery-reared cutthroat trout (Salmo clarki). A resident population of this species exists in the stream. The experimental procedure was to introduce groups of trout into enclosures 1/2 to 3/4 mile long; each trout in a group was given a numbered Petersen tag and weighed before planting. Recapture by angling and reweighing were carried out throughout the season of planting and also in later summers. In this way six lots of pond-reared, one lot of stream-reared, and one lot of transplanted wild cutthroat trout were studied. Pond-reared fish exhibited very low survivals over the first (0 to 4.9 percent) and second (0 to 3.1 percent) winter. Survival was largely independent of age. Transplanted wild trout showed survivals of 46.0 to 29.0 percent to the second and third summers, respectively.

Stream-reared hatchery fish gave an intermediate value (17.2 percent to the second summer).

All lots of trout lost weight for some 30 or 40 days when superimposed on a resident population. This loss was more severe and was regained more slowly in pond-reared trout than in transplanted wild trout.

It is held that the low survivability of hatchery fish is due to the absence of natural selection at early stages in the life history. (A)

11. Smith, Lloyd L. Jr. and Laurits W. Krefting. 1954. FLUCTUATIONS IN PRODUCTION AND ABUNDANCE OF COMMERCIAL SPECIES IN THE RED LAKES, MINNESOTA, WITH SPECIAL REFERENCE TO CHANGES IN THE WALLEYE POPULATION. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 131-160.

The Red Lakes in northwestern Minnesota comprise 275,000 acres of water which support a commercial fishery producing up to 1.5 million pounds of fish per year. Walleye, Stizostedion vitreum vitreum (Mitchill), and yellow perch, Perca flavescens (Mitchill), are the principal species. Statistics for the past 37 years have been analyzed and fluctuations in the abundance of the important species calculated for the 24-year period, 1930-1953. The fishing is carried on exclusively with 3 1/2-inch-mesh (extension measure) gill nets by Chippewa Indians and the catch is marketed through a cooperative fishery enterprise. There have been wide fluctuations in the abundance of principal species but, although fishing effort has increased greatly during the past few years no trends have developed. Changes in walleye abundance have been shown to be independent of changes or levels of fishing effort, and to be determined by strength of individual year classes. Gear competition has no effect on abundance estimates. Strength of year classes is not correlated with size of brood stock, abundance of competing species, or amount of hatchery fish planted. Weather conditions cannot be correlated with observed changes in strength of year classes. Implications for management include provision of adequate prediction of abundance, and annual adjustment of fishing practices to make greatest use of the available stock. Gear limitations should be designed to secure harvest at optimum size of fish and to provide a suitable economic status for the fisherman. (A)

12. Larkin, P. A. and S. B. Smith. 1954. SOME EFFECTS OF INTRODUCTION OF THE REDSIDE SHINER ON THE KAMLOOPS TROUT IN PAUL LAKE, BRITISH COLUMBIA. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 161-175.

The redside shiner (Richardsonius balteatus) was introduced into Paul Lake, British Columbia about 1945 and by 1952 was abundant in the lake. Some effects of this introduction on Kamloops trout (Salmo gairdneri kamloops), previously the only other species of fish in the lake, are described. The summer diet of trout underwent marked changes and in 1952 shiners constituted a main item of diet for trout longer than 30 centimeters, fork length. Average stomach volumes of the smaller trout decreased subsequent to introduction of shiners. Growth rate declined and trout did not reach legal size (roughly 20 centimeters) until they were more than 2 years old. Previously, yearling trout had contributed substantially to the fishery. Change in growth rate has intensified the selection by the sport fishery of faster growing fish. A decline in the success of fishing and a drop in angling pressure have resulted in a decrease in catch to less than one-half of the previous annual total. These changes are discussed in relation to predation by shiners on trout fry, predation by trout on shiners and competition for food between shiners and trout. (A)

13. Huish, Melvin T. 1954. LIFE HISTORY OF THE BLACK CRAPPIE OF LAKE GEORGE, FLORIDA. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 176-193.

A study of the life history of the black crappie Pomoxis nigromaculatus (LeSueur), from Lake George, Florida, was made in 1949 and 1950. Few previous attempts to determine the age of fish from Florida waters have been made because of several difficulties in reading scales. Scale readings of 943 black crappie revealed that the 1947 and 1948 year classes were stronger numerically than the 1949 year class. The readings also indicated that few fish reached the IV group or older. Males and females showed only minor differences in growth. Calculations of growth from scale measurements yielded the following estimates of length at the end of the first five years of life: first—4.4 inches; second—8.1 inches; third—9.9 inches; fourth—11.5 inches; and fifth—12.5 inches.

Determination of age and growth from length-frequency distributions of 15,575 fish indicated that the crappie had an average length of 5.5 inches in their first year, 8.5 inches in the second year, 10.3 inches in the third year, and 11.7 inches in the fourth year. Examination of scales showed that the black crappie made most of its annual growth from April through November; length-frequencies indicated growth from May through October. The black crappie of Lake George grew at a rate similar to that of other stocks from southeastern waters.

The sex ratio varied from month to month during the year; females outnumbered males in every month but July and August during 1950. Most of the males and females became ripe in February, March, or April. The crappie spawns for the first time at the age of 2 years as no male crappie less than 7.0 inches in total length and no females less than 8.0 inches long were found in spawning condition.

Graphical and tabular representations are given of the length-weight relationship. Factors for converting from standard to total length and from total to standard length were derived from measurements of 1,950 crappie.

The average number of pounds of crappie caught per seine haul in Lake George varied almost inversely with the average water temperature. The

greatest catches occurred during November, December, and January in the 2 years of the study. (A)

14. Vibert, Richard. 1954. EFFECT OF SOLAR RADIATION AND OF GRAVEL COVER ON DEVELOPMENT, GROWTH, AND LOSS BY PREDATION IN SALMON AND TROUT. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 194-201.

Several earlier researchers have pointed out that trout and salmon fry hatched under gravel are hardier than those reared in a hatchery. The present report confirms these observations, and tries to delineate the effect of certain environmental factors on the embryonic development of salmon fry. Salmon fry (Salmo salar) hatched under gravel were better developed, more deeply pigmented, and on the average 15 percent heavier than those hatched in troughs. The average number of vertebrae was significantly influenced by solar radiation and by gravel cover. The separate effects of these two environmental conditions, tended to obscure one another. Vertebral malformations were numerous in fry hatched under gravel in total darkness. Mortality, caused by blue-sac disease at the time of the spring run-off of snow water was less among brown trout (Salmo fario) alevins hatched in gravel than among hatchery reared alevins. Rainbow trout (Salmo gairdneri irideus) fingerlings hatched under gravel were less vulnerable to predators (eels) than fingerlings hatched in hatchery troughs. (A)

15. Parsons, John W. 1954. GROWTH AND HABITS OF THE REDEYE BASS. Trans. Am. Fish Soc., Vol. 83 (1953), pp. 202-211.

A study of the redeye bass, Micropterus coosae Hubbs and Bailey, was conducted on Sheed's Creek in southeastern Tennessee during the years 1950 through 1953. This fish is common in Georgia and Alabama and also occurs in several small streams in Tennessee. The redeye bass is primarily a fish of small upland streams and is seldom found in lakes or ponds. In comparison with other black basses, the redeye bass has an average life span, grows slowly, and is relatively slender. Of the 6,363 redeye bass scales examined, 82 percent were regenerated. This occurrence of scale regeneration was higher than in 13 other species of fish in eastern Tennessee streams. This report on the redeye bass includes information on the standard length-total length relationship, length-weight relationship, growth rate, parasites, food habits, spawning habits, fecundity, maturity, distribution, migration, and angling importance. The redeye bass has been propagated successfully in Tennessee hatchery ponds and has been introduced experimentally into 10 small streams of middle Tennessee that have proven to be unsuitable for either warmwater game fish or trout. (A)

16. Harkness, W. J. K., Justin W. Leonard and Paul R. Needham. 1954. FISHERY RESEARCH AT MID-CENTURY. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 212-216.

In North America fishery research is approached by almost as many administrative avenues as there are agencies engaged in it. Between these agencies differences exist in needs, plans, staff organization, methods of enlisting public support, and in the application of research findings. This situation is desirable. In the comparative infancy of fishery science any tendency toward development of stereotyped doctrine should be deplored. Originality and eclecticism should be encouraged both in training institutions and in research and administrative bodies. An objective review of apparent successes and failures to date, however, may prove of value in illuminating pitfalls and in pointing out procedures which have resulted in progress. From this review profitable methods and promising areas for future activity may be inferred by the reader. (A)

17. Allison, Leonard N. 1954. ADVANCEMENTS IN PREVENTION AND TREATMENT OF PARASITIC DISEASES OF FISH. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 221-228.

The most recent advancement in control of external organisms causing fish disease is the pond-treatment method. It is an improvement over the hand-dipping method because fish are not killed by handling, fewer men are needed to carry it out, and the pond itself is treated along with the fish. All external parasites are controlled by a treatment with formalin (diluted to 1:4000) for an exposure of 1 hour, except Ichthyophthirius multifiliis, parasitic copepods, and species of Saprolegnia. I. multifiliis can be controlled by holding affected fish in swiftly running water for several weeks or by chemical treatment of the water for the duration of the life cycle of the parasite. Free-swimming larvae of the copepod Salmonicola edwardsii can be killed by chemical added to the water; because of the parasite's long life cycle, treatment would hardly be feasible at large hatcheries. Saprolegnia sp. (fungus) can be killed readily by dipping fish in a 1:15,000 solution of malachite green for 10 to 30 seconds, or by introduction of the chemical into the pond for 45 minutes at a dilution of 1:180,000. Fish eggs can be kept fungus-free by semi-weekly treatments with a 1:200,000 concentration of malachite green.

Comparatively few internal parasites cause mortalities among fish. Octomitus salmonis can be controlled by adding 0.2-percent calomel or carbarsone to the food for 4 days. Adult tapeworms of the genus Proteocephalus can be purged from fish by feeding for 1 week food containing 1 1/2- to 2-percent kamala. Fish can be protected from the eye fluke (metacercaria of Diplostomum flexicaudum) by killing all snails in the pond and preventing entrance of infective cercariae with the supply water. (A)

18. Gordon, Myron. 1954. THE GENETICS OF FISH DISEASES. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 229-240.

The clearest evidence for the hereditary determination of diseases in fishes comes from the genetic studies of melanomas. This neoplastic disease in platyfish-swordtail hybrids is initiated,

intensified, or inhibited by genetic factors. The development of melanomas depends upon the interaction of a sex-linked, dominant gene obtained from the platyfish and a number of dominant modifying genes obtained from the swordtail. During the past 5 years, evidence has been discovered for the hereditary influence in the development of thyroid tumors in a species of Mexican swordtails. The disease closely resembles the well known thyroid tumors in trout, described about 50 years ago. Kidney tumors of thyroid-cell origin have been detected in several strains of platyfish. In other strains of the same species, living under similar conditions and diets, the kidney tumors have not developed. Several examples are presented of death of fish embryos from hereditary causes. Some skeletal abnormalities of fishes may be traced to injurious genes. The hereditary factors involved in diseases and abnormalities are generally complex and difficult to detect, but the evidence for their existence is undeniable. (A)

19. Griffin, Philip J. 1954. THE NATURE OF BACTERIA PATHOGENIC TO FISH. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 241-253.

A review is made of the progress in research on bacteria which are pathogenic to fish, with particular emphasis on those investigations performed during the past decade. The report includes a critical review of material published; the comments and suggestions are designed to stimulate the initiation of new research projects. (A)

20. Halver, John E. 1954. FISH DISEASES AND NUTRITION. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 254-261.

Malnutrition in fish population, although recognized by the earliest workers in fish culture, has only recently received intensive study commensurate with that in other fields of animal nutrition. Recent experimental test diets have produced specific deficiency syndromes for most of the vitamins and have indicated the possibility of developing specific deficiencies for amino acids, fatty acids, and other basic nutrients. During the past 3 years the first evidence of susceptibility to bacterial disease in lots of fish with sub-clinical manifestations of vitamin deficiencies has opened an entire new field in fish-disease study.

In this review (a portion of a symposium on fish diseases) the nutrition of salmonids is emphasized. Advancements within the last 10 years in the fields of avitaminosis, hypervitaminosis, susceptibility to disease and general malnutrition are mentioned and a table is included which compares the specific avitaminosis syndromes observed in fish with those observed in other experimental animals. (A)

21. Nigrelli, Ross F. 1954. TUMORS AND OTHER ATYPICAL CELL GROWTHS IN TEMPERATE FRESHWATER FISHES OF NORTH AMERICA. Trans. Am. Fish. Soc. Vol. 83 (1953), pp. 262-296.

This report deals with any abnormal tissue, the growth of which exceeds and is uncoordinated with that of the normal tissue. Included in this category are the neoplasia (benign and cancerous), non-functional hyperplasias, cellular hypertrophy as well as other atypical cell growths. The following topics are discussed with special reference to the temperate freshwater fishes of North America: papillomas, hyperplastic epidermal diseases (including fish pox), parasitic and neoplastic adenomas, carcinomas (including thyroid tumors), fibromas, fibro-sarcomas, myxomas, leiomyomas, rhabdomyomas, granulomas, lymphosarcomas, pigment-cell tumors, neurofibromas, neurilemmonas, hamartomas, and teratomas.

The role of such factors as physical and chemical irritants, nutrition, endocrine disfunction, heredity, embryonic disturbances, and such infectious agents as viruses, bacteria, mycotic organisms, and protozoans in the production of these abnormalities is given or suggested.

With the exception of certain tumors, our knowledge concerning neoplasms in fishes in general is extremely limited and very few contributions have been made by American fishery biologists. It is suggested that a greater effort be made to recognize these diseases, especially tumors which appear spontaneously in large populations of fishes. (A)

22. Rucker, Robert R., Brian J. Earp, and Erling J. Ordal. 1954. INFECTIOUS DISEASES OF PACIFIC SALMON. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 297-312.

Investigations on infectious diseases of Pacific salmon due to micro-organisms other than viruses are reviewed. The etiological agents include trematodes, fungi, protozoa and bacteria. Bacteria have been found to be the most important agents of disease in the several species of Pacific salmon. Kidney disease, due to a small unnamed Gram-positive diplobacillus, causes serious mortalities in young salmon reared in hatcheries. The disease has also been found in wild fish. Aquatic myxobacteria are important agents of disease both in the hatchery and in the natural habitat. One of the myxobacteria, Chondrococcus columnaris, causes disease at relatively high water temperatures. The problem of the taxonomy of this organism is discussed. Another myxobacterium, Cytophaga psychrophila, has been found responsible for epizootics in coho salmon at lower water temperatures, i.e., in the range of 40° to 55° F. In outbreaks of gill disease in young salmon, myxobacteria of several kinds have been implicated.

A variety of bacteria has been found responsible for outbreaks of disease in salmon in sea water. The most important of these is a species of Vibrio. Tuberculosis has been found in adult chinook salmon and the evidence indicates that the disease was contracted at sea. (A)

23. Snieszko, S. F. 1954. THERAPY OF BACTERIAL FISH DISEASES. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 313-330.

During the past decade considerable progress has been made in the therapy of bacterial fish diseases. This progress was possible largely because of the introduction of powerful chemotherapeutic agents such as sulfonamides and antibiotics.

Fish furunculosis can be treated with very good results with sulfamerazine, sulfamethazine, and sulfaguanidine as well as by chloramphenicol and terramycin. Ulcer disease caused by Hemophilus piscium resists treatment with sulfonamides but responds well to the above mentioned antibiotics.

Chemotherapy of fish diseases caused by pseudomonads is possible with chloramphenicol, but sanitary measures are preferred. External disinfections with Roccal and pyridylmercuric acetate (PMA) are satisfactory in treatment and prophylaxis of gill diseases which are probably caused by superficial infections with myxobacteria. Sulfonamides are helpful in systemic infections with myxobacteria and are also being used with some success for the control of a recently described kidney disease of salmonoid fishes.

Also described are methods of control of other fish diseases and of immunity in cold-blooded animals and fishes. Most of the drugs in the described treatments may be toxic to fishes, and therefore should be used with caution. (A)

24. Watson, Stanley W. 1954. VIRUS DISEASES OF FISH. Trans. Am. Fish. Soc., Vol. 83 (1953), pp. 331-341.

Viruses are probably the cause of a wide spectrum of fish diseases. Although relatively few virus diseases of fish are known today, some of the diseases of unknown etiology, as well as some diseases presently accepted as due to bacteria, protozoa, fungi or nutritional deficiencies, possibly will be recognized eventually as virus diseases.

Some viruses may induce proliferative tissue changes whereas others may cause degenerative change. Although several diseases of a proliferative nature have been reported to be of virus origin, positive experimental evidence for the transmission of a virus from one fish to another, has been presented for only lymphocystis.

The degenerative or non-neoplastic diseases of possible virus origin give the fish culturist the most concern because of the severe mortalities resulting from infection. Epizootics of this nature have been reported in carp (Cyprinus carpio) and rainbow trout (Salmo gairdneri) in Europe, in acara (Geophagus brasiliensis) in South America, in kokanee, (Oncorhynchus nerka kennerlyi) and in sockeye salmon (Oncorhynchus nerka nerka) in the State of Washington. It has been demonstrated that each epizootic was caused by an infectious filterable agent, probably a virus. (A)

25. Wolf, Louis E. 1954. DEVELOPMENT OF DISEASE-RESISTANT STRAINS OF FISH. Trans. Am. Fish. Soc., Vol. 83 (1953), 342-349.

Some of the achievements in selective breeding of animals for resistance to diseases are discussed. The literature on disease resistance among strains of trout within a species is reviewed. The known mechanisms of disease resistance are discussed in relation to the problem of creating maximum resistance through selective breeding.

A brief report is made on the results of the first 11 months of operation of a Dingell-Johnson project of breeding brook and brown trout for resistance to ulcer disease and furunculosis. (A)

26. Lawler, G. H. 1954. OBSERVATIONS ON THE TROUT-PERCH PERCOPSIS OMISCOMAYCUS (WALBAUM), AT HEMING LAKE, MANITOBA. J. Fish. Res. Bd. Can., Vol. XI, No. 1, January. pp. 1-4.

Trout-perch of Heming Lake attain III years of age and 90 mm. in fork length. In May they ascend small tributaries to spawn on silt and boulder bottoms, at a temperature of 40° -50° F. Average egg content was 349, with range 210-728 in 11 fish. Trout-perch taken in the lake were infested with 0 to 6 cysts each (av. 1.4) containing plerocercoids of the cestode Triaenophorus stizostedionis. Most cysts were in the liver or gonads, very few in the muscle. Trout-perch were eaten in large numbers by pike, Esox lucius, and much less frequently by walleye, Stizostedion vitreum. Only the latter contained adult Triaenophorus stizostedionis. (A)

27. Martin, N. V. 1954. CATCH AND WINTER FOOD OF LAKE TROUT IN CERTAIN ALGONQUIN PARK LAKES. J. Fish. Res. Bd. Can., Vol. XI, No. 1, January. pp. 5-10.

Winter catches of lake trout in the sports fishery exceeded those taken at other times of the year in some Algonquin Park lakes. The size of the fish caught was generally smaller because of the different type of gear used in winter. The winter fishing also exploited a high percentage of the immature stock.

The winter diet was less varied than at other seasons and there was a high percentage of empty stomachs. Bottom feeding was negligible in most lakes, but, in some, insect larvae were taken more frequently than at any other time of the year. Plankton feeding was at a low level in winter even in those lakes which have predominantly plankton-feeding populations in summer. In these same lakes the absence of thermal barriers permitted trout to feed more frequently on fish in winter and also on a greater variety of fish species. Populations feeding on fish in summer continued to do so in winter. As the winter progressed, there was a decline in the frequency of plankton in the stomachs and an increase in fish and bottom fauna. (A)

28. Jampolsky, A. and W. S. Hoar. 1954. GROWTH HORMONE FROM SALMON PITUITARY GLANDS. J. Fish. Res. Bd. Can., Vol. XI, No. 1, January. pp. 57-62.

Injections of an alkaline extract of the anterior lobe of beef pituitary produced a prolonged acceleration of growth in rats and a temporary increase in weight of goldfish. A comparable extract of salmon pituitaries (Oncorhynchus tshawytscha) had no effect on growth of rats but produced a slight temporary increase in growth of goldfish. Negative effects of salmon extracts on rats are considered significant, but all effects on goldfish are questioned since the extracts were not free of toxicity. (A)

29. Potter, Gilbert D. and William S. Hoar. 1954.

THE PRESENCE OF ANDROGENS IN CHUM SALMON (ONCORHYNCHUS KETA WALBAUM). J. Fish. Res. Bd. Can., Vol. XI, No. 1, January. pp. 63-68.

Testes of mature chum salmon (Oncorhynchus keta Walbaum) were examined histologically for interstitial cells and extracts of testes assayed biologically for the presence of androgens. The histological examination showed numerous interstitial cells similar to those described in some other fish and in mammals. The bioassay established the presence of androgenic substance (probably testosterone). The amount present in salmon testes was calculated to be roughly equivalent to the amount present in mammalian testes. (A)

30. Hoar, William S. 1954. THE BEHAVIOUR OF JUVENILE PACIFIC SALMON, WITH PARTICULAR REFERENCE TO THE SOCKEYE (ONCORHYNCHUS NERKA). J. Fish. Res. Bd. Can., Vol. XI, No. 1, January, pp. 69-97.

Behaviour patterns of juvenile sockeye salmon in fresh water are compared with those of chum and coho salmon. Both sockeye and chum fry are schooling fish, responding positively to currents and avoiding shallow waters. Of the two species, chums, however, form more active schools, travel more rapidly, have a less marked cover reaction and prefer stronger light and shallower water. Sockeye smolts, in contrast to coho smolts, are more active, show little thigmotactic and territorial behaviour and a more persistent response to current. The experimental findings are discussed in relation to the migratory behaviour of these fish. It is suggested that sockeye fry, emerging from cover as the light intensity falls are displaced downstream after dark. Moderate activity and a marked preference for deep water are mechanisms postulated for continued residence of sockeye fry in lakes. Further it is suggested that the smolt exodus is due to heightened general activity, both day and night, associated with strong response to current. This brings sockeye smolts into the outflow from the lake where they hold position during the day but are displaced down the river after dark. Coho smolts responding less vigorously to currents and maintaining a measure of contact with specific objects in their environment, move seaward more slowly than sockeye. (A)

31. Hasler, Arthur D. 1954. ODOUR PERCEPTION AND ORIENTATION IN FISHES. J. Fish. Res. Bd. Can., Vol. XI, No. 2, March. pp. 107-129.

This paper presents a review of the literature on the olfactory organs in fishes, taste, perception of food odours, environmental odour perception, and odours of aquatic plants. A discussion on the commercial application of odour perception and the orientation to parent stream by odour is presented. Illustrations of several pieces of equipment used in experiments are included along with a good bibliography.

32. Kleerekoper, H. and E. C. Chagnon. 1954. HEARING IN FISH, WITH SPECIAL REFERENCE TO SEMOTILUS ATROMACULATUS ATROMACULATUS (MITCHILL). J. Fish. Res. Bd. Can., Vol. XI, No. 2, March, pp. 130-152.

The literature on hearing in fish is reviewed. Experiments with Semotilus a. atromaculatus (Mitchill) showed perception over a range from 1 to 5,750 c.p.s. Fish from which the ears had been removed seemed to perceive frequencies from 20 to 200 c.p.s. Fish without the lateralis nerve behaved as normal fish. Normal fish could distinguish one-fifth of an octave in the range of 50 c.p.s. Trained on 50 c.p.s. they had absolute pitch for 70 c.p.s. A threshold curve over the range of 20 to 5,750 c.p.s. was established for this species.

Highest sensitivity was at 280 c.p.s.; lowest at 20 c.p.s. and above 2,000 c.p.s. The movements of the fish in response to vibration stimuli were studied by means of motion pictures. The fish were able to locate the source of vibration, most likely oriented by fields of higher intensity in the experimental tank. In approaching the source the fish followed curved pathways. The relationships between length of pathway, direct distance from source of vibrations, and speed of locomotion were analysed. Measurements of sound intensity in the experimental tank indicated that intensity gradients existed along the pathways followed by the fish. Further measurements of low frequency vibrations in the water are in progress. (A)

33. Sullivan, Charlotte M. 1954. TEMPERATURE RECEPTION AND RESPONSES IN FISH. J. Fish. Res. Bd. Can., Vol. XI, No. 2, March, pp. 153-170.

Conditioned-response experiments show that both bony fishes and selachians have surface thermal receptors. Electrophysiological studies have demonstrated in selachians two mechanisms which could provide continuous information about constant temperature conditions—the ampullae of Lorenzini and the lateral-line system. In other fishes only one such mechanism has been demonstrated, namely the trunk lateral-line system. Impulses from the ampullae and the lateral-line organs are, apparently, always being poured into the central nervous system at a rate which is characteristic of the temperature of the environment. The change in frequency of these action potentials with a given change in temperature is not great and there is no sign of adaptation. These sensory receptor mechanisms could operate in such a way as to give fish an absolute sense of temperature. In addition to this non-adaptive effect of temperature on these two kinds of receptors, there occurs, in the ampullae of Lorenzini only, another spectacular change in frequency of the nerve impulses with change in temperature, and this response is adaptive. This effect disappears with continued exposure to the new temperature, and the spontaneous impulses gradually assume the stable frequency which is characteristic of the temperature.

The principal effects of temperature on the activities of fish are as follows: Fish moving in a temperature gradient select a particular temperature because of an effect of the gradient temperatures on their movements. When fish move through the temperatures of a gradient, the frequency of their movements is least in the selected region. Moderately rapid changes of temperature do not elicit locomotor responses from resting fish until very high temperatures are reached, but do affect the frequency of movements of active fish. The frequency of spontaneous movements is related to the equilibration temperature, being greatest at the temperature ordinarily selected by the same fish if placed in a temperature gradient. Maximum cruising speed, as measured at different equilibration temperatures, is greatest at the selected temperature, as is also the distance moved in response to an electric shock. The maximum cruising speed that can be maintained by fish increases, with acclimation temperature, to a peak at the final preferendum.

Temperature selection by fish in a gradient is a function of surface thermal receptors not in the trunk lateral line, and of the forebrain. The relation between frequency of spontaneous movements and equilibration temperature depends in some way upon the integrity of the cerebellum.

There are a few instances where a correlation has been demonstrated between temperature conditions and behaviour of fish in nature because of the effect of temperature on activity. There are other instances in which distribution of fish in nature appears to be correlated with temperature as a result of selection responses to temperature gradients. (A)

34. Kennedy, W. A. 1954. TAGGING RETURNS, AGE STUDIES AND FLUCTUATIONS IN ABUNDANCE OF LAKE WINNIPEG WHITEFISH, 1931-1951. J. Fish. Res. Bd. Canada, Vol. XI, No. 3, May, pp. 284-309.

On the basis of 2,003 lake whitefish, Coregonus clupeaformis, tagged in 1938, of which 126 were recovered during the next five years, there is evidence that fish released together tend to stay together for years, and that the proportion of a population captured during a certain time by a unit amount of fishing effort can fluctuate greatly (a plausible explanation is the effect of variations in weather conditions). On the basis of age determinations of 12,975 whitefish in samples taken annually from 1937 to 1951, growth rate was determined, the total annual mortality rate among fully exploited fish was calculated to be 64 per cent over several years, and it appeared that all year-classes had been of about equal strength in recent years. The generally accepted idea that fluctations in fishing success correspond to fluctuations in abundance of whitefish is probably erroneous. Possibly the Lake Winnipeg whitefish are underfished. (A)

35. Brett, J. R. and D. MacKinnon. 1954. SOME ASPECTS OF OLFACTORY PERCEPTION IN MIGRATING ADULT COHO AND SPRING SALMON. J. Fish. Res. Bd. Canada, Vol. XI, No. 3, May, pp. 310-318.

A series of tests was conducted to investigate the sense of smell in migrating coho (Oncorhynchus kisutch) and spring salmon (O. tshawytscha). By pouring dilute solutions of each of 54 substances into the path of the salmon moving up a fish ladder at Stamp Falls, B. C., positive responses were noted by recording changes in the rate of migration. Representative samples of alcohols, aldehydes, ketones, esters, organic acids and oils, as well as shark repellent and a pulp-mill effluent caused no significant change in the migration. However, dilute water rinses of mammalian skins had distinct repellent action. An acute olfactory sense enabling adult Pacific salmon to detect predators from a downstream position was considered to have survival value. The use of mammalian predator skins to repel salmon from destructive river locations is suggested. (A)

36. Foerster, R. E. 1954. ON THE RELATION OF ADULT SOCKEYE SALMON (ONCORHYNCHUS NERKA) RETURNS TO KNOWN SMOLT SEAWARD MIGRATIONS. J. Fish. Res. Bd. Can., Vol. XI, No. 4, July, pp. 339-350.

Data were obtained from Cultus Lake giving (a) the number of seaward migrating smolts each year from 1927 to 1944, (b) their mean length and weight, and (c) the number of adults from each smolt migration which returned in the spawning escapement to the lake. These indicate a negative correlation— .5 : 24, $P < 0.05$) between number of smolts and percentage return of adults. By multiple regression this is shown to be related almost wholly to the size of the smolts. With an increase in average weight of smolts from 4 to 10 grams, their average percentage survival is tripled.

Smolt size and numbers together account for about 60 per cent of the variation in actual number of adult salmon which arrive at the lake. The residual variability could not be definitely related to available qualitative indices of fishing intensity or duration. (A)

37. McCrimmon, H. R. 1954. STREAM STUDIES ON PLANTED ATLANTIC SALMON. J. Fish. Res. Bd. Can., Vol. XI, No. 4, July, pp. 362-403.

Plantings of Atlantic salmon fry were made in the Duffin Creek system in order to determine the survival and distribution of salmon under a variety of stream conditions. Population studies estimated that the three general June plantings resulted in an average survival of 12.7 percent until the autumn of the first year, 9.2 percent until the autumn of the second year. High summer temperatures were lethal to the salmon in certain parts of the creek system. Over the balance of the planted part, the greatest mortality occurred soon after plantings when heavy predation by other species of fish occurred. The extent of predation was determined largely by the amount of shelter available to the fry. Suitable shelter for the young salmon was limited generally to gravelly riffle areas where the degree of bottom sedimentation determined the amount of

shelter offered. Other stream conditions were of minor or no importance in salmon survival. Further losses of salmon were low once the young salmon had become established in the creek system. (A)

38. Wisby, Warren J. and Arthur D. Hasler. 1954. EFFECT OF OLFACTORY OCCLUSION ON MIGRATING SILVER SALMON (O. KISUTCH). J. Fish. Res. Bd. Can., Vol. XI, No. 4, July, 472-478.

Silver salmon were captured in traps in Issaquah Creek and its East Fork. The olfactory pits of approximately one-half of the fish were occluded before all of them were displaced to the Issaquah about one mile below the junction of the two streams. The control salmon, unlike those which occluded olfactory pits, showed an excellent ability to repeat their original choice at the stream juncture. This is interpreted to mean that the operated fish were not able to differentiate between the two streams but were distributing themselves in a random fashion. The results, therefore, are in accord with those which would be expected if the fish were relying on their sense of smell in making this choice. (A)

39. McMahon, V. H. 1954. THE ABUNDANCE AND DISTRIBUTION OF ENTOMOSTRACAN PLANKTON AT LAKELSE LAKE, B. C., 1949-1952. J. Fish. Res. Bd. Can., Vol. XI, No. 4, July, pp. 479-499.

Greatest concentrations of entomostracans at Lakelse Lake in 1949 were in the upper half of a 30-metre column. The copepods were quite uniform in horizontal distribution over the deeper part of the lake while the cladocerans tended to concentrate at the north end. A high abundance of entomostracans occurred between mid-July and mid-October. Sampling at the deepest station only may be sufficient to give an indication of the total incidence of Cyclops sp. in the lake, but a true representation of total abundance of the other entomostracans cannot be obtained by this restricted method of sampling. An apparent decline in the occurrence of entomostracans following 1949 can probably be attributed, in part at least, to a change in efficiency of the collecting nets used. (A)

40. Miller, Richard B. 1954. MOVEMENTS OF CUTTHROAT TROUT AFTER DIFFERENT PERIODS OF RETENTION UPSTREAM AND DOWNSTREAM FROM THEIR HOMES. J. Fish. Res. Bd. Can., Vol. XI, No. 5, September, pp. 550-558.

A homing experiment of cutthroat trout (Salmo clarki) was carried out in Gorge Creek, a small trout stream more or less typical of the streams of the eastern slopes of the Rocky Mountains in Alberta. A half-mile portion of the stream was screened off and, into the enclosure thus formed, 105 trout were transferred from above and 104 from below. Each of these was given a numbered tag and the home locality was recorded. The transfers were made from June 24 to August 13. On August 15 the screens were removed; from September 3 to 5 most of the experimental area was poisoned with Fish Tox and the localities of tagged fish recorded. It was found that most of the trout that had been confined for 30 or more days remained in the enclosure area, i.e., they had adjusted to new homes. The exceptions appear to be the result of random movements. Trout of upstream origin, confined for less than 30 days, move toward their original home territory. Trout of downstream origin, confined for less than 30 days, show very much less ability to move toward or to find their homes. The hypothesis is put foward that trout are guided by smell in finding home.

A few observations on size of home territory suggest that it is small, perhaps not more than 20 yards of stream. Trout may inhabit the same area of stream for at least three years. (A)

41. Ricker, W. E. 1954. STOCK AND RECRUITMENT. J. Fish. Res. Bd. Can., Vol. XI, No. 5, September, pp. 559-623.

Plotting net reproduction (reproductive potential of the adults obtained) against the density of stock which produced them, for a number of fish and invertebrate populations, gives a domed curve whose apex lies above the line representing replacement reproduction. At stock densities beyond the apex, reproduction declines either gradually or abruptly. This decline gives a population a tendency to oscillate in numbers; however, the oscillations are damped, not permanent, unless reproduction decreases quite rapidly and there is not too much mixing of generations in the breeding population. Removal of part of the adult stock reduces the amplitude of oscillations that may be in progress and, up to a point, increases reproduction. (A)

42. Robertson, J. G. 1954. THE TROPHIC STATUS OF PORT JOHN LAKE, BRITISH COLUMBIA. J. Fish. Res. Bd. Can., Vol. XI, No. 5, September, pp. 624-651.

Port John Lake is situated on King Island on the central British Columbia coast. Area is about 0.35 square miles (910,000 sq. m.). The drainage basin is 3.6 square miles (9.3 sq. km.) with an igneous foundation supporting a coniferous forest. Annual precipitation is 116 inches (295.5 cm.). An oligotrophic lake, it has a volume development of 1.53 and a mean depth of 82.2 feet (25.1 m.). The thermal stratification is second order, temperate, of the Whipple classification. The summer heat income is approximately 11,000 gram-calories per sq. cm. The ratio of 0_2 in the hypolimnion to 0_2 in the epilimnion is 6.58. Total dissolved solids are 39 ppm. at the lake surface.

Large amounts of organic matter are washed into the lake imposing a potential stress on its oligotrophy. However, dredge and net collections, which are dominated by chironomids and cladocerans, respectively, contained very few organisms. Plankton was most abundant in the surface water.

Low production of organisms is partly the result of the heavy rainfall which dilutes the trophic stratum above the hypolimnion, and the small amount of sunlight reaching the lake. (A)

43. Slastenenko, E. P. 1954. THE RELATIVE GROWTH OF HYBRID CHAR (SALVELINUS FONTINALIS X CRISTIVOMER NAMAYCUSH). J. Fish. Res. Bd. Can., Vol. XI, No. 5, September, pp. 652-659.

Hybrid char from Banff were intermediate between the two parental species, lake trout and eastern brook trout, in respect to relative growth of some characters; in others they approximated one or other of the parent species. However, it was not possible to make comparisons with parent-species material of the same stock as the hybrids' parents and reared under the same conditions. (A)

44. Bangham, Ralph V. and James R. Adams.1954. A SURVEY OF THE PARASITES OF FRESHWATER FISHES FROM THE MAINLAND OF BRITISH COLUMBIA. J. Fish. Res. Bd. Can., Vol. XI, No. 6, November, pp. 673-708.

Examination of 5,456 fish of 36 different species during 1951 and 1952 showed 4,925 or 90 per cent to be infected with at least one species of parasite. Records include fish from many lakes and streams of the Columbia and Fraser drainages and from a few localities in the Skeena, Peace, Liard and Skagit drainages. Parasites are recorded for each species of fish from each locality. The incidence of parasitism in the fish was comparable with that found by other surveys in eastern Canada and the United States. No major differences were found in the parasite faunas of the different river systems. Most of the common parasites were forms of circumpolar or general North American distribution. Several species of parasites described only from the Pacific coast area were common in certain hosts. Introduced species of fish showed very light infections with but few species of their normal parasites. The parasite fauna of fishes of this area appears to be less varied than in eastern and southern parts of the continent. (A)

45. Kennedy, W. A. 1954. GROWTH, MATURITY AND MORTALITY IN THE RELATIVELY UNEXPLOITED LAKE TROUT, CRISTIVOMER NAMAYCUSH, OF GREAT SLAVE LAKE. J. Fish. Res. Bd. Can., Vol. XI, No. 6, November, pp. 827-852.

Ages of 9,215 lake trout were determined. Length-weight and time-maturity relationships are shown. Sex ratio is 1:1. Only half the females of mature size spawn each year. There is no growth except during June to September, inclusive. There is a tremendous difference in size at a given age. Growth is much faster in one half of the lake than in the other, it is the same as or slightly slower than in lakes farther south and considerably faster than in Great Bear Lake. Seven years of commercial fishing did not increase total annual mortality by much. Mortality rate increases with age among all fish of catchable size. A given year-class probably attains maximum biomass well before most of its members reach commercial size. No significant variation in year-class strength was found. (A)

46. Lawler, G. H. and W. B. Scott. 1954. NOTES ON THE GEOGRAPHICAL DISTRIBUTION AND THE HOSTS OF THE CESTODE GENUS TRIAENOPHORUS IN NORTH AMERICA. J. Fish. Res. Bd. Can., Vol. XI, No. 6, November, pp. 884-893.

The known range of the genus Triaenophorus in North America lies between 42° N. latitude (Indiana, U.S.A.), northward to 67° N. latitude (Great Bear Lake, Northwest Territories, Canada), and from the lower St. Lawrence River northwesterly to Alaska. The southern limit of distribution of the genus appears to be closely related to the 70° July isotherm. An hypothesis of the origin and dispersal of the genus is given. From published records and personal communications, the genus is reported to occur in 32 species of fish. (A)

47. Vladykov, Vadim D. 1954. TAXONOMIC CHARACTERS OF THE EASTERN NORTH AMERICA CHARS (SALVELINUS AND CRISTIVOMER). J. Fish. Res. Bd. Can., Vol. XI, No. 6, November, pp. 904-932.

For the present study about 300 specimens have been examined. These specimens belong to the six species of chars: C. namaycush, S. fontinalis, S. aureolus, S. oquassa, S. marstoni, and S. alpinus. Among meristic characters, the number of pyloric caeca was found to be very important. Body proportions and meristic characters, such as fin rays and vertebrae, are inadequate to properly describe a species. On the other hand, the skull bones, different teeth, and skeleton of the tail are sufficient in themselves to define a species. The pearl organs were found only in C. namaycush of both sexes. The taxonomic relation between species is as follows: C. namaycush belongs to a distinct genus; S. fontinalis represents a subgenus Baione; while the remaining chars are grouped in a subgenus Salvelinus. (A)

48. Wickett, W. Percy. 1954. THE OXYGEN SUPPLY TO SALMON EGGS IN SPAWNING BEDS. J. Fish. Res. Bd. Can., Vol. XI, No. 6, November, pp. 933-953.

By using standpipes set 12 inches into the stream bottom the oxygen content and apparent velocity of the gravel water in the controlled-flow section of Nile Creek were observed. Values of dissolved oxygen content and velocity that just supply the full oxygen demand of salmon eggs were defined. The high mortalities of chum salmon eggs in the pre-eyed stage, that have been found in certain areas, may be explained on the basis that oxygen demands of 0.00013 to 0.0003 mg./egg/hr. at temperatures of 0.1° to 8.2° C. were not being met, owing to very low oxygen content or very low apparent velocity of the water in the gravel. Values as low as 0.2 p.p.m. and 2 mm./hr. were recorded. A portable gravel-water sampler is described, which can be used (1) to obtain samples of subsurface water for the determination of dissolved oxygen; and (2) to calculate apparent velocity of gravel water from rate of dilution of an added dye. (A)

49. Foerster, R. E. 1954. SEX RATIOS IN SOCKEYE SALMON (ONCORHYNCHUS NERKA). J. Fish.

Res. Bd. Can., Vol. XI, No. 6, November, pp. 988-997.

A low male:female ratio (average for 14 years—32.4% males) occurs in the sockeye salmon spawning escapements to Cultus Lake. Factors likely to cause such unequal sex representation are examined. Sex ratios of seaward-migrating smolts (7 years' records) were found to approximate 50:50. Selection of male fish by the gill-net fishery, while contributing, does not appear great enough. Therefore, a greater mortality of male sockeye during the period of ocean residence seems indicated, and records for two series of data are presented. (A)

50. Stone, Udell B., Donald G. Pasko and Robert M. Roecker. 1954. A STUDY OF LAKE ONTARIO–ST. LAWRENCE RIVER SMALLMOUTH BASS. N. Y. Fish and Game Journal, Vol. 1, No. 1, January, pp. 1-26.

A study of smallmouth bass of the eastern Lake Ontario—Thousand Islands region was carried on during 1944-50. Tagging of 4,408 wild, adult bass at 10 principal localities was undertaken to determine if populations were homogeneous. Studies of age, growth and reproduction of the bass from different localities were made. Metal strap tags used on the dorsal fin and maxillary during 1944-45 gave recoveries of only 2.0 per cent and 9.1 per cent, respectively. During 1946-50 round, metal strap tags, applied to the lower jaw, were used on a total of 2,853 fish. This method gave 612 recoveries (21.5 per cent). Angling recoveries were used as an index to the catch of bass on various grounds during different months of the fishing season. Despite a relatively heavy take of bass on some grounds during June there was no evidence that the early fishing affected the population adversely. Heaviest returns, generally, were in August. Distinct populations of bass were recognized using migrations and growth as the main criteria for separation. Four to 6 years are required in this area for bass to reach the legal length of 10 inches. The oldest bass found were 14 years old. Considerable variation in spawning time was found to be a characteristic of bass in this region. Late May to early June spawning occurred in tributary streams and in some of the warmer bays while late June-July spawning occurred among the fish influenced by the cold water of Lake Ontario. (A)

51. Haskell, David C., John MacDougal and Donald Geduldig. 1954. REACTIONS AND MOTION OF FISH IN A DIRECT CURRENT ELECTRIC FIELD. N. Y. Fish and Game Journal, Vol. 1, No. 1, January, pp. 47-64.

Because the use of direct current has definite advantages in the collection of fish by electrical means, a study was undertaken of the reactions of fish subjected to this type of current. It was found that the migration of fish to the positive electrode in the direct current shocker technique is involuntary. The motion toward the positive pole is believed to result from shock to the nerve endings in the muscles. Steady direct current modifies the normal swimming motion and guides the fish toward the positive pole. Intermittent direct current causes an involuntary motion consisting of a turn toward the positive pole and forward motion at each circuit closure. The motion resulting from intermittent current is more pronounced than that produced by steady current. The intermittent effect requires a lower voltage than that of steady current. Therefore, intermittent direct current may be effective for lower line voltages and greater electrode separations than steady current.

To combine the effects of steady and intermittent direct current a cycle of 0.8 second on followed by 0.2 second off is tentatively recommended. The voltage rise on circuit closure must be rapid.

Theoretical physiological considerations are discussed which indicate a possibility that several hundred pulsations per second may be practical. This rapid rate of pulsation might be combined with a slow on and off cycle. (A)

52. Haskell, David C., John MacDougal and Roderic Freeman. 1954. TWO BACK-PACK FISH SHOCKERS. N. Y. Fish and Game Journal, Vol. 1, No. 1, January, pp. 65-74.

The considerations involved in the design of a back-pack fish shocker are discussed.

The circuits and electrical performance data are presented for two such units. Each weighs about 30 pounds including carrying case. The first is adapted for use only in soft and moderately hard water; the second will operate quite effectively in waters with resistivities of 1,500 to 28,000 ohms per centimeter cube. (A)

53. Burdick, G. E., Morris Lipschuetz, Howard J. Dean and Earl J. Harris. 1954. LETHAL OXYGEN CONCENTRATIONS FOR TROUT AND SMALLMOUTH BASS. N. Y. Fish and Game Journal, Vol. 1, No. 1, January, pp. 84-97.

Curves for the mean oxygen concentrations lethal to fish over short exposure periods have been constructed for brook, brown, and rainbow trout and smallmouth bass. Equations are formulated to fit the straight-line curve obtained on semi-logarithmic paper. Lethal oxygen concentrations are determined at several temperatures by a procedure that involves the gradual reduction of oxygen by fish respiration in a sealed container to complete loss of equilibrium used as an end-point. The highest and lowest concentrations producing such an effect are noted for each temperature. It is not suggested the data obtained by this experimental procedure represent points above which fish can be maintained indefinitely, nor that slow and gradual acclimatization will not result in shifting the mean lethal level, but curves derived are believed to represent the lethal concentrations for certain hatchery trout and, reasonably well, fish under natural stream conditions. It is claimed the experimental procedure closely approximates the rapid decrease in oxygen in streams that is produced by intermittent discharges of organic wastes, and a comparison with conditions in one such polluted stream is made. (A)

54. Barbehenn, Kile. 1954. THE EFFECTS OF DUCKS ON THE DEVELOPMENT OF FILAMENTOUS ALGAE IN FARM FISHPONDS. N. Y. Fish and Game Journal, Vol. 1, No. 1, January, pp. 110-115.

To test the efficacy of ducks as controllers of filamentous green algae on farm fishponds, mallards were stocked on 21 farm ponds in south-central New York and on shallow ponds at the Cornell University Fish Hatchery at Ithaca. Observations were also made on three ponds bearing domestic mallard derivatives and muscovies. Field results indicated that the farm pond ducks had no appreciable effect on the algae. Observations at the hatchery suggested that, under conditions of concentration, ducks may destroy part of the algal mat by agitation or may retard development by increasing turbidity, but they are not capable of preventing undesirable amounts of algal growth. (A)

55. Haskell, David C. 1954. ELECTRICAL FIELDS AS APPLIED TO THE OPERATION OF ELECTRIC FISH SHOCKERS. N. Y. Fish and Game Journal, Vol. 1, No. 2, July, pp. 130-170.

Experiments were conducted in an outdoor pond to determine the nature of electric fields that might be used in the operation of fish shockers. As a preliminary phase of the work, the electrical fundamentals, upon which successful use of such a shocker depends, were determined.

The paralysis voltage for brown trout (defined as the voltage, measured from the head to the tail of a fish, sufficient to stop motion instantly) was found to be 3.1 ± 0.3 volts, using alternate current. Paralysis voltage is independent of the size of the fish, at least over a range of 3 to 11 inches. Paralysis voltage is independent of the type of water over the tested range of water resistivity of 6,250 to 35,000 ohms per centimeter cube. Since it requires the same voltage on the fish to stun a large fish as a small one, a large fish, because of its greater length, may be stunned with an electrode-to-electrode voltage too low to affect a small fish. Tentatively, the same voltage gradient required for successful alternating current shocking is believed adequate for direct current "attraction".

The resistivity of fish flesh (hatchery brown trout) is approximately 1,500 ohms per centimeter cube. When a fish is placed in an electric field in water having a resistivity higher than that of the fish flesh, the field immediately surrounding the fish is distorted resulting in a lower voltage on the fish. The reduction in voltage in soft water (35,000 ohms per centimeter cube) makes necessary a 60 per cent increase in generator voltage to produce the same effect as in hard water (1,500 ohms per centimeter cube).

All electric shocker circuits have linear characteristics. Thus, doubling generator voltage doubles the current, and doubles the voltage in any part of the circuit.

With a typical grounded system, and an electrode 14 1/2 feet long, 33 per cent of the generator voltage appeared in the water under the electrode, 27 per cent was lost within 2 feet of the ground bars, while the remainder was distributed in the soil between the ground bars and a point under the electrode.

Tests of various types of grounds showed that the most effective of those tried consisted of large pieces of screening laid on the bottom, and covered with soil and stones. Multiple and widely spaced grounds of any type were better than a single ground.

Tests of two-electrode systems with paddle-type electrodes showed that the electrode material (whether screening, perforated metal, or solid sheet metal) makes practically no difference. The larger the electrodes, the greater the separation may be. The electric field is somewhat more effective when the electrodes are held near the bottom, than when they are near the surface.

The data suggest that one may quite accurately think of each paddle-type electrode as producing an effective field around itself which is reasonably constant as electrode separation is increased. There is an effective field between the electrodes only when they are sufficiently close together than the circles of effectiveness surrounding them intersect.

One alternate-polarity-electrode system was studied and is described. Collected data indicate that, with a system using two parallel electrodes, increasing the length of each electrode greatly increases the field strength between them.

Apparatus for measuring water and soil resistivity is described. (A)

56. Burdick, G. E. 1954. AN ANALYSIS OF THE FACTORS, INCLUDING POLLUTION, HAVING POSSIBLE INFLUENCE ON THE ABUNDANCE OF SHAD IN THE HUDSON RIVER. N. Y. Fish and Game Journal, Vol. 1, No. 2, July, pp. 188-205.

The total reported take of shad in the Hudson River from 1924 to 1951 has been corrected for number of nets and permitted fishing hours and expressed as per cent of the average to give a value for abundance that can be readily compared year by year. Expression of the fishing pressure on a similar basis enables comparison to evaluate possible overfishing. It has been concluded that overfishing occurred when the fishing period was increased from 108 to 136 or more hours per week.

The 5-year progression of shad return has been used to show a positive relationship to change in the net lift, indicating pollution was not a factor in recent decline. Flow data for the Hudson River have also been used to show that no relationship exists between streamflow and the size of the fifth year return, further evidence that pollution is not a factor.

Oxygen data are presented for the river. Further oxygen determinations made at the time of collection of young shad have shown that young shad may be present at oxygen values even below 4.0 p.p.m. This appears to indicate that the figure given by Ellis et al. as a minimum for young shad may not be applicable to all natural waters. Support is given this belief by the work

reported by Talbot. It is concluded that the minimum standard of 4.0 p.p.m. of oxygen for warm-water fishery waters is adequate for waters containing shad. (A)

57. Webster, Dwight A. 1954. A SURVIVAL EXPERIMENT AND AN EXAMPLE OF SELECTIVE SAMPLING OF BROOK TROUT (SALVELINUS FONTINALIS) BY ANGLING AND ROTENONE IN AN ADIRONDACK POND. N. Y. Fish and Game Journal, Vol. 1, No. 2, July, pp. 214-219.

A 4.6-acre Adirondack pond was reclaimed in 1951 and was restocked with four groups of brook trout from wild and domestic sources in 1952 with the intent to observe relative survival. Owing to the inadvertent introduction of gill lice with one group of wild fish, the experiment was prematurely terminated in 1953. Angling in the pond and two subsequent treatments with rotenone produced different ratios in the recovery of the stocked fish and of a group of naturally produced trout, the results of natural spawning in 1951 by adult trout which were missed in the original treatment. The ratio of the recovery for the four groups of stocked fish differed significantly from that expected on the basis of the stocking ratio. (A)

58. Greenwald, Margaret. 1954. LIST OF REFERENCES ON CONTROL OF AQUATIC PLANTS, INCLUDING ALGAE. Published by the Research Div., Chipman Chemical Co., Inc., Bound Brook, N. J., 24 pp. mimeo., December.

This is not a complete bibliography according to the author, but it lists 292 publications.

59. Johnson, Waldo E. and Arthur D. Hasler. 1954. RAINBOW TROUT PRODUCTION IN DYSTROPHIC LAKES. J. Wildlife Mgt., Vol. 18, No. 1, January, pp. 113-134.

After rotenone removal of resident fishes, rainbow trout were established and maintained by stocking in some small dystrophic lakes in northern Wisconsin and Upper Michigan. The vital statistics of these populations at various levels of standing crop were followed.

Based on a decline in growth rate at higher levels of standing crop, the carrying capacity of these lakes for pure populations of rainbow trout appears to be approximately 50 pounds per acre.

Water temperature, availability of zooplankton, size of trout and size of standing crop of trout are considered as the factors determining growth in these lakes with competition being the most important factor at high levels of standing crop. The results suggest that availability of food, temperature, and size of the trout are all density-dependent factors.

The amount of natural mortality appears to be entirely dependent on the number of predators present and not on the density of the trout.

Dystrophic lakes or other lakes without oxygen below the epilimnion in midsummer appear to be well suited for management as rainbow trout lakes in areas where the mean July air temperature is less than 70° F. (21° C.).

Although lime treatment in such lakes increases the volume of habitable water, this seemingly results in no increase in production or carrying capacity.

The importance of findings in this study to fish management procedures and the need for additional research are discussed.

60. Clothier, William D. 1954. EFFECT OF WATER REDUCTIONS ON FISH MOVEMENT IN IRRIGATION DIVERSIONS. J. Wildlife Mgt., Vol. 18, No. 2, April, pp. 150-160.

Four canals from the West Gallatin River, Montana, were selected for a study of trout, whitefish, and sucker movement following abrupt water reductions. Fish taken from each canal during the regular irrigation season were marked and returned to the water within the section where caught.

The entire distance from the headgate to the last section in which fish were marked (4200 to 7500 feet) was censused in each canal after the water was turned off.

Water in three canals was decreased three days prior to headgate closure. One of these ditches had a period of reduced flow coincidental with the natural lowering of river level. The fourth canal served as a control, and it was turned off without a preliminary reduction period.

Game fish concentrations were found immediately behind the headgate in the two canals having one period of decreased flow before headgate closure. Of the marked recoveries, 73 percent in one canal and 100 percent in the other were recaptured upstream from point of release for distances varying from 150 to 7500 feet.

Only 12.1 percent of the game fish poundage in the control canal was found in the section immediately behind the headgate, and 51.4 percent of the marked recoveries were recaptured as far as 2550 feet downstream from the point of release.

Fish concentrations were found wherever brush, undercut banks, and pools furnished concealment. These areas of concentration were often small and widely separated, suggesting that reduced flow effected a redistribution of the fish population.

61. Larimore, R. Weldon. 1954. DISPERSAL, GROWTH, AND INFLUENCE OF SMALLMOUTH BASS STOCKED IN A WARM-WATER STREAM. J. Wildlife Mgt., Vol. 18, No. 2, April, pp. 207-216.

Smallmouth bass were added to a known indigenous population of this species in Jordan Creek, Vermilion County, Illinois. The survival, growth, and dispersal of both the native and stocked fish were followed to determine factors controlling the population density of bass in small streams.

The four-mile study area of Jordan Creek was censused one year before (1950) and one year after (1952) the new bass were stocked. The July-September census of 1952 showed that 75 percent of the pond-reared bass were still in the one-half-mile division in which released or in the next one-half-mile division upstream. Smallmouths stocked from Stony Creek, a nearby stream, revealed no special pattern of distribution but were scattered

singly up and down the stream.

The longer the pond-reared fish were in the stream the greater was their tendency to remain in one place. Growth of the stocked bass during their first season in Jordan Creek was as good as that of the indigenous smallmouths. There was no indication in this season that competition of the stocked bass affected the growth of the native smallmouths. Also, there was no evidence in the year after stocking that the introduced bass caused a decline in the total number of native smallmouths.

62. Pendleton, Robert C. and Earl W. Smart. 1954. A STUDY OF THE FOOD RELATIONS OF THE LEAST CHUB, IOTICHTHYS PHLEGETHONTIS (COPE), USING RADIOACTIVE PHOSPHORUS. J. Wildlife Mgt., Vol. 18, No. 2, April, pp. 226-228.

This study was undertaken to perfect a method for accurate food-chain determination with radioactive isotopes. It was also designed to determine some of the food bases for the cyprinid fish, Iotichthys phlegethontis, and to determine the role of this fish in mosquito predation. The food species used in this series of tests included the small water flea, Hyalella knickerbockeri Bate, the ostracod, Herpetocypris chevreuxi (Sars), and mosquito larvae, Aedes niphadopsis DeGare.

Although brief and incomplete, the findings indicate that the labelling of suspected food species with P^{32} or other beta-emitting radioelements is practical in research on food chains of fishes.

63. Boussu, Marvin F. 1954. RELATIONSHIP BETWEEN TROUT POPULATIONS AND COVER ON A SMALL STREAM. J. Wildlife Mgt., Vol. 18, No. 2, April, pp. 229-239.

A study was made of the relationship of eastern brook trout, rainbow trout, and brown trout populations to cover in Trout Creek, Gallatin County, Montana. Fourteen sections were established as study areas. These sections were selected on the basis of presence or absence of cover features such as over-hanging brush and under-cut banks. Cover on eight sections was altered, five sections were unaltered and used as controls, and one section was used for general observations. All sections were inventoried before and after alteration. A comparison of pre-alteration and post-alteration populations was made. The addition of brush cover to four sections increased the total pounds by an average of 1.60 per inventory. Populations in three control sections increased an average of 0.23 pounds per inventory. The removal of brush from two sections resulted in a decrease in total pounds of fish per inventory of 1.71. A control section increased in total pounds by an average of 0.18 per inventory. A decrease in total pounds per inventory was also noted following removal of under-cut bank from two sections.

Aquatic vegetation appeared to be of value as cover when rooted to the stream bottom and also while free-floating.

64. Threinen, C. W. and William T. Helm. 1954. EXPERIMENTS AND OBSERVATIONS DESIGNED TO SHOW CARP DESTRUCTION OF AQUATIC VEGETATION. J. Wildlife Mgt., Vol. 18, No. 2, April, pp. 247-251.

In southeastern Wisconsin where the carp problem is most acute, experiments were performed in 1951 and 1952 to determine the destructiveness of carp to aquatic vegetation under natural conditions.

Circular chicken-wire exclosures 16 feet in diameter were erected in three lakes in areas with differing bottom, vegetative and wave exposure characteristics. In only one exclosure was there an increase in aquatic vegetation. The unexpected results may have been due to heavy silt deposits caused by action of carp in roiling the bottom.

Fencing an entire bay, however, demonstrated the prolific nature of the vegetation and the potential of carp for the destruction of vegetation.

65. Tryon, C. A., Jr. 1954. THE EFFECT OF CARP EXCLOSURES ON GROWTH OF SUBMERGED AQUATIC VEGETATION IN PYMATUNING LAKE, PENNSYLVANIA. J. Wildlife Mgt., Vol. 18, No. 2, April, pp. 251-254.

In Pymatuning Lake, 1/100-acre paired quadrats, fenced and unfenced, were established. These quadrats were in operation during the vegetation growing seasons of 1950, 1951, and 1952. The three-year average annual growth of submerged aquatics was 3.9 grams of air-dried vegetation per square meter in fenced quadrats and 1.4 grams per square meter in unfenced quadrats. The rooting and splashing habits of carp appeared to be responsible for differences in production of submerged aquatics, although other causes may be responsible.

66. Brock, Vernon E. 1954. A PRELIMINARY REPORT ON A METHOD OF ESTIMATING REEF FISH POPULATIONS. J. Wildlife Mgt., Vol. 18, No. 3, July, pp. 297-308.

A method of estimating number and weight of reef fish by means of submarine counts and length estimates is described. The method involves the use of self-contained compressed-air diving apparatus by two divers, each counting all fish seen in a path 20 feet wide by 1,500 feet long, thus covering a combined area of 60,000 square feet.

Some 17 trials of the method at nine different localities indicated that estimates of stocks of fish present would seem to be sufficiently consistent to make the method useful.

67. Nelson, Perry H. 1954. LIFE HISTORY AND MANAGEMENT OF THE AMERICAN GRAYLING (THYMALLUS SIGNIFER TRICOLOR) IN MONTANA. J. Wildlife Mgt., Vol. 18, No. 3, July, pp. 324-342.

An investigation of grayling in the Centennial Valley, Montana, was made during the summers of 1951 and 1952 to develop a management plan for grayling in one area of its original range.

In 1951 grayling were found in two lakes and five creeks. They were most abundant in Upper Red Rock Lake where the catch (1951 and 1952) with 125-foot graded experimental gill nets averaged 2.05 per

hour. The grayling population was greatest in Red Rock Creek during spawning in May and June and gradually decreased during the summer. The decrease was partly due to predation and downstream movement. In 1952 the average numbers captured with an electric shocker in 600-foot sections of stream were 5.3 (June 28-July 1), 2.0 (August 12-14), and 0.5 (September 15-17). A total of 370 fish was marked and 14 were recovered.

Spawning was observed between May 19 and June 6, 1952, in Red Rock Creek, and between May 23 and June 1 in Antelope Creek. No spawning was observed or grayling eggs found in bottom materials composed of sand or silt.

The period between fertilization and hatching of the eggs was estimated to be 14-19 days where the water temperatures varied from 38° to 61° F.

The average calculated total lengths in inches for the various age groups of grayling in the Centennial Valley were: Age Group I, 6.1; Group II, 11.1; Group III, 13.5; Group IV, 14.7; Group V. 15.6; and Age Group VI, 16.0.

An experiment removing all fish except grayling in sections of Red Rock Creek was tried. However, grayling did not occur in sufficient numbers to evaluate effects of fish removal.

A management plan is proposed to control fishing, irrigation, artificial stocking, beaver, and erosion.

68. Lane, Charles E., Jr. 1954. AGE AND GROWTH OF THE BLUEGILL, LEPOMIS M. MACROCHIRUS (RAFINESQUE), IN A NEW MISSOURI IMPOUNDMENT. J. Wildlife Mgt., Vol. 18, No. 3, July, pp. 358-365.

This study describes age and growth of a developing population of bluegill in a new flood-control reservoir. It is based on 1,496 bluegill collected from Clearwater Lake, Missouri, from 1949, the year following impoundment, to 1952. Body-scale and length-weight relationships, time of annulus formation and duration of spawning are discussed.

A decreasing rate of growth was found for successive year classes within any one age group. This decrease was explained in terms of an increasing population of bluegill and other species of fishes, a restricted food supply, and delayed nesting due to fluctuating water levels.

69. Robins, C. Richard and Ronald W. Crawford. 1954. A SHORT ACCURATE METHOD FOR ESTIMATING THE VOLUME OF STREAMFLOW. J. Wildlife Mgt., Vol. 18, No. 3, July, pp. 366-369.

A description of a new proposed method for measuring stream flow is presented and compared to the method described by Embody. The new method is based on the fact that the total volume of water flowing in a stream flows through every cross-section. The float method, herein described, involves one width measurement, three depth measurements and the timing of a float at three places. A stop watch is the only special equipment needed. Determinations are usually made within a few minutes. Volume of flow R in each segment of the cross-section is determined by the following formula: R= W D a V. Total flow is found by adding the flows for the three segments.

70. Holloway, Ancil D. 1954. NOTES ON THE LIFE HISTORY AND MANAGEMENT OF THE SHORTNOSE AND LONGNOSE GARS IN FLORIDA WATERS. J. Wildlife Mgt., Vol. 18, No. 4, October, pp. 438-449.

This study, undertaken to clarify the position of gars in a fish management program was started along with other studies on Ocala National Forest, Florida. Collecting methods are described. Feeding habits, behavior, sex ratios, spawning and egg counts are presented for both the shortnose and longnose gar. Gar control as an instrument in fish management is discussed.

71. Cleary, Robert E. and John Greenbank. 1954. AN ANALYSIS OF TECHNIQUES USED IN ESTIMATING FISH POPULATIONS IN STREAMS, WITH PARTICULAR REFERENCE TO LARGE NON-TROUT STREAMS. J. Wildlife Mgt., Vol. 18, No. 4, October, pp. 461-477.

Current methods of estimating fish populations in rivers and streams are discussed. Reasons for using fishways, traps, weirs, creel censuses, electric shockers or markings are presented.

72. Martin, Alexander C. 1954. IDENTIFYING POLYGONUM SEEDS. J. Wildlife Mgt., Vol. 18, No. 4, October, pp. 514-520.

Twenty-two of the more common or important species of Polygonum seeds have been illustrated and keyed, with a brief discussion heading the article.

73. Butler, George E. 1954. SPORT FISHING—COMMERCIAL FISHING RELATIONSHIPS IN MANITOBA. Trans. of the 44th Convention of the International Assoc. of Game, Fish and Conservation Commissioners, pp. 29-35.

This article deals with the problems arising from conflicting interests in Manitoba lakes and streams with respect to commercial and sport fisheries. Three situations are discussed: (1) Waters in which both sport fishermen and commercial fishermen carry on angling and commercial fishing without serious conflict, (2) waters in which an established commercial fishery has been in operation for many years and in which, in recent years, angling pressure has become a factor of importance in the over-all catch of fish, and (3) waters in which an established sport fishing industry has grown up, and in which commercial fishing interests bring pressure to bear upon the administration to permit commercial fishing.

74. Schwob, Carl E. 1954. NATIONAL PICTURE IN THE FIELD OF POLLUTION ABATEMENT. Trans. of the 44th Convention of the International Assoc. of Game, Fish and Conservation Commissioners, pp. 115-121.

The conservation and development of our water resources concern every area of the country and all segments of the population. Increased commercial use has caused much pollution in many rivers and streams. The Federal policy for pollution control

is discussed and a comprehensive program of development for pollution control to be carried out through close cooperation of the Federal government, the States, cities and industries is outlined.

75. 1954. A SYMPOSIUM ON WATERSHED MANAGEMENT GOALS. Trans. 19th N. A. Wildlife Conference, pp. 38-79.

Papers presented at the General Session on Watershed Management Goals dealt with the following topics: "What is Watershed Conservation?", "The Place of Forest and Range in Watershed Management," "The Place of Parks and Recreation in Our New Programs for Watershed Conservation," and "The Place of Stream Pollution Control in Watershed Management." These papers were prepared by D. A. Williams, H. G. Wilm, Kirk Fox, Howard Zahniser and J. H. Bender, respectively.

76. Shetter, David S., Marvin J. Whalls and O. M. Corbett. 1954. THE EFFECT OF CHANGED ANGLING REGULATIONS ON A TROUT POPULATION OF THE AU SABLE RIVER. Trans. 19th N. A. Wildlife Conference, pp. 222-238.

The North Branch of the Au Sable River, lying about 200 miles north of Ann Arbor in Michigan's Lower Peninsula, has long been regarded as one of the State's better brook trout streams. Originally the Au Sable drainage was noted for its grayling fishing. The grayling decline began in about 1880. In 1885, in an effort to replace the grayling, the Michigan Fish Commission planted 20,000 brook trout fry in the Main Au Sable. Introduction of brown and rainbow trout fry followed by 1891.

The early brook trout plantings soon provided excellent fishing in the North Branch. However, in 1926 the ratio of brook trout to rainbow trout was only 4:1, and in the 1950-1953 period, partial creel census records for the stream sections with unchanged regulations suggested a species ratio of 2.7 brook trout to 1 brown trout.

In 1949 the legal limit was changed from 8 inches to 10 inches on that portion of the North Branch between Lovells Bridge and the county line, also the daily limit was 10 trout, not more than five of which could be brook trout, and only artificial flies were permitted. Results of these added restrictions were that: (1) Except for 1950, more angling trips were recorded on the restricted water than on the normal water; (2) the percentage of successful fishing trips on the restricted water increased regularly each year from 10.4 in 1950 to 23.3 per cent in 1953, (3) The observed catch of brook trout larger than 10 inches from the restricted water also increased each year, (4) angling quality has been best in the normal stream sections each year, and (5) the weight and length of trout caught was consistently greater from the restricted area, due to the increased legal length.

Information on the population left each fall after the fishing season was obtained by electrofishing with an AC shocker. The numbers of trout caught per hour were used as indices of changes in population density.

Protection of a high proportion of fish to a size which permits them to spawn at least once, and elimination of considerable hooking mortality among fish less than the minimum legal length by utilizing a "flies only" regulation are the main factors responsible for the brook trout population increase in the restricted water and the progressive enlargement in the total catch of the species there.

77. Cooper, Gerald P. and Robert N. Schafer. 1954. STUDIES ON THE POPULATION OF LEGAL-SIZE FISH IN WHITMORE LAKE, WASHTENAW AND LIVINGSTON COUNTIES, MICHIGAN. Trans. 19th N.A. Wildlife Conference, pp. 239-259.

An estimate of the population of legal-size game fish in Whitmore Lake was made during the spring of 1953 using a commercial type of trap net for collecting fish, and using the Schmacher and Eschmeyer (1943) and Schnabel (1938) formulas in the mark-and-recapture procedure of estimating population size. The extensive net collections also provided data for analyses of age and growth, total mortality rate, distribution of fish within the lake, and adequacy of sample size in connection with growth studies.

Whitmore Lake has a population of warm-water game and coarse fishes which is quite typical of lakes of southern Michigan. The bluegill is by far the predominant fish in the lake, among species which exceed a length of six inches. Other abundant species include the pumpkinseed, black crappie, rock bass, largemouth bass, yellow perch, northern pike, yellow bullhead, brown bullhead, bowfin and lake chubsucker.

The conclusion is that the population of fish, by species, in a lake even as small as Whitmore (677 acres) is not distributed uniformly over the lake, even within a particular year class of one species. Rather there appear to be significant differences not only in abundance but in age- and size-frequency distributions with a given species. These differences were found to be related to depth of water and geographical locations on the lake, but the differences are probably primarily related to food, cover, and other factors vital to the fish.

78. Bennett, George W. 1954. THE EFFECTS OF A LATE-SUMMER DRAWDOWN ON THE FISH POPULATION OF RIDGE LAKE, COLES COUNTY, ILLINOIS. Trans. 19th N.A. Wildlife Conference, pp. 259-270.

The concept of the use of the drawdown for the improvement of fishing is not new, but this concept has been based largely on circumstantial evidence. This preliminary experiment at Ridge Lake, an artificial impoundment of about 17 acres in Fox Ridge State Park near Charleston, Illinois, suggests that there may be a considerable difference in the effect of a severe drawdown upon various segments of a fish population. The drawdown had almost no effect on bass numbers, while bluegill numbers among the small fishes were drastically reduced.

The September 1951 and 1952 drawdown of 15 feet exposed the entire bottom of the littoral plant zone, which at that time of year was filled with fairly

dense stands of potamogetons and other submerged-rooted aquatics. The forced migration of aquatic animals and small fishes from the protection of the aquatic vegetation into the open water and the concentration of these animals and small fishes in a reduced volume of water as the lake level receded made the invertebrates more readily available as food to the larger fishes. Therefore, competition for food among the fishes became greater. It was concluded that the drawdown was too severe from the standpoint of its influence upon the bluegill population. Perhaps a drop in water level of 10 feet which would have reduced the lake area by about 35 per cent, would have permitted a larger survival of bluegills and a somewhat larger bluegill yield in 1952 without seriously reducing either the growth rate of bluegills or the success of bass spawning.

79. Pfitzer, Donald W. 1954. INVESTIGATIONS OF WATERS BELOW STORAGE RESERVOIRS IN TENNESSEE. Trans. 19th N. A. Wildlife Conference, pp. 271-282.

The construction of large dams in the Tennessee Valley has caused major changes in the ecology of the waters below them.

A lower average temperature, 50° to 55° F., a reduction of the extreme temperatures, 39° to 65° F., and an erratic seasonal dissolved oxygen pattern has resulted.

Great daily fluctuations in water velocity and volume take place. These changes in water have brought about great changes in the plant and animal populations. Many of the minnow species have disappeared. Only a few species of those remaining are successfully reproducing. The bottom faunal pattern has changed from large warm-water species to small cold-water species. The most abundant groups are members of the insect families Tendipedidae, Simuliidae and Hydropsychidae along with the scud, Gammarus, and snails. The plant populations are dominated entirely by algae of several species. These plants attain tremendous growths in some areas.

Experimental planting of rainbow trout fingerlings has shown that this species is very well suited for continued management. Brook trout have not survived tailwater conditions.

80. Raney, Edward C., William S. Woolcott and Albert G. Mehring. 1954. MIGRATORY PATTERN AND RACIAL STRUCTURE OF ATLANTIC COAST STRIPED BASS. Trans. 19th N. A. Wildlife Conference, pp. 376-396.

This study gives the findings of an expanded investigation of racial stocks of Atlantic Coast striped bass, (Roccus saxatilis). Details of the results of the Schaefer-Salt Water Sportsman tagging program are also presented. Counts were made on young or yearlings, unless otherwise specified.

The important sources of striped bass are known to be Albemarle Sound, Chesapeake Bay, Delaware Bay and the Hudson River. The study of races of striped bass by Raney and de Sylva (1953) concentrated largely on the Hudson and Chesapeake stocks. Further material is now available and is analyzed for those two waters and samples or data also have been obtained for the St. Lawrence River; Miramichi River, New Brunswick; Shubenacadie River, Nova Scotia; Albemarle Sound, North Carolina and several localities in South Carolina.

A study of tag returns indicates that in the late spring the Hudson race, or a portion thereof, regularly moves to the western end of Long Island Sound. In the fall there is a reverse movement into the Hudson River. This study generally confirmed the findings of Merriman (1941) that striped bass of the Chesapeake race apparently migrate independently and strike off the New Jersey shore, the south and southeast shore of Long Island from where they move almost directly north to such well-known bass areas as Niantic River, Point Judith, Rhode Island, and northward. During the fall, most make their way southward to the New Jersey coast and the Delaware and Chesapeake Bays.

Racial studies using fin ray counts confirm previous findings of an upstream race which is found in the Hudson at Haverstraw and northward. The lower Hudson, south of Haverstraw, has a population of young which at least on some years are derived from Chesapeake stock or bass with similar characters. On the basis of the character index the Hudson race is separated 70 per cent from the Chesapeake race. The dorsal count gives the best separation of any single character; the count is 11 more often than 12 in the Hudson race and the reverse in the Chesapeake race.

Evidence is presented of a possible endemic stock in Nova Scotia which is close in some counts to southern populations in Albemarle Sound and the Edisto and Santee Rivers, South Carolina. The Albemarle Sound population seems to be endemic or nearly so although it is closely related to Chesapeake stock. The South Carolina stock is virtually 100 per cent separable from the Albemarle Sound stock on fin ray and low lateral line scale counts. There is additional evidence of subraces within Chesapeake Bay and there is a hint that upstream populations may differ in having lower counts.

81. Roedel, Phil M. 1954. CALIFORNIA'S TUNA AND YELLOWTAIL TAGGING PROGRAMS. Trans. 19th N. A. Wildlife Conference, pp. 404-417.

Successful means of tagging various species of tuna and the yellowtail (Seriola dorsalis, a carangid fish) have been developed since 1951 by the California Department of Fish and Game.

A tag made of flexible plastic tubing and affixed through the flesh of the back posterior to the second dorsal fin was devised by the tuna investigators. It has been modified several times and as now manufactured consists of a protective exterior translucent tube inside of which is an opaque white tube bearing the legend. There are two types. In one, the interior tube is longer than the exterior and is used for tying the loop closed. In the other, the interior tube is shorter than the exterior, and the tag is tied with a length of nylon line passed through both tubes.

The tubing tags have proved extremely satisfac-

tory. They are relatively easy to apply, there is no evidence of shedding, the tagging wound heals rapidly, and the tags are readily seen by fishermen.

A number of tags, including the tubing tag, were tested in the field, in an aquarium and in a water tunnel. The only type comparing favorably with the tubing tag in retention quality is a cellulose jaw tag which is affixed to the lower jaw through a slit made in the isthmus. There have been no known losses from either tubing or jaw tags.

In a recent experiment yellowfin and skipjack were released between northern Mexico and northern Peru, albacore off California and Baja California, Mexico, and bluefin and yellowtail off Baja California.

The most important recovery to the time the paper was written was that of an albacore tagged off southern California and recaptured off Japan.

82. Collins, Gerald B. 1954. RESEARCH ON ANADROMOUS FISH PASSAGE AT DAMS. Trans. 19th N. A. Wildlife Conference, pp. 418-423.

The multitude of dams resulting from the development of our water resources for power, irrigation, navigation and flood control is seriously threatening the existence of our anadromous fisheries. A broad program of fisheries engineering with research directed toward an economic solution of fish passage problems in the Columbia River is being underwritten by the U. S. Army Corps of Engineers.

A major part of the research effort is being directed toward the protection of downstream migrants. Experiments are being conducted both in the laboratory and field and include electricity, lights, louvers, sound, odors, screens of air bubbles, and other mechanical devices.

By comparison the problems in providing upstream passage seem relatively easy. However, present fishways are oversize, inefficient and far too expensive. A special laboratory is planned at Bonneville Dam to undertake the study of the principles of fish passage.

83. Younger, Roy R. and Paul E. Hamer. 1954. NEW JERSEY'S SALT WATER SPORT FISHERY INVENTORY, 1953. Trans 19th N. A. Wildlife Conference, pp. 423-429.

Aware of the heavy fishing pressure, both recreational and commercial, upon the coastal waters, the New Jersey Division of Fish and Game, in January 1952, inaugurated an inventory of her sport fishery. It was anticipated that such a survey would yield the following information: (1) The number of anglers utilizing this resource, (2) the number of man-days fished by each phase of the fishery, bank, surf, party boats, charter boats, rowboats and U-drives, (3) the major species taken by each type of angling, (4) the need, if any, to manage the fishery on a state level, and how it could be accomplished, and (5) to obtain any major trends in the fishery from year to year. This article outlines the obstacles encountered in initiating this survey and how they were overcome.

84. Hubbs, Clark. 1954. CORRECTED DISTRIBUTIONAL RECORDS FOR TEXAS FRESH-WATER FISHES. The Texas J. of Science, Vol. VI, No. 3, September, pp. 277-291.

This paper corrects many misidentifications contained in past lists of Texas fishes and redefines several species ranges. Specimens from many collections were re-examined.

85. Cuerrier, Jean-Paul. 1954. THE HISTORY OF LAKE MINNEWANKA WITH REFERENCE TO THE REACTION OF LAKE TROUT TO ARTIFICIAL CHANGES IN ENVIRONMENT. The Canadian Fish Culturist, Issue 15, April, pp. 1-9.

The lake trout population of Lake Minnewanka in Banff National Park has suffered several ecological changes resulting from successive increases in the water level through dam building for electric power development. This lake, which was once popular for its lake trout angling, is now almost depleted of large individuals of that species and inhabited by a dense population of small lake trout.

The present status of the lake trout population is demonstrated by the fact that the catch of lake trout by angling or by netting consists almost exclusively of fish measuring less than the legal length of 15 inches.

Observations made with an underwater television camera have indicated that spawning grounds for lake trout are still available in deep waters and that eggs were laid at depths beyond the limit of lower water. It seems that the annual drawdown of water has not interfered with lake trout spawning activities.

In 1941, lake trout between 8 and 12 inches in length represented 17.6 per cent of the total catch by gill nets. From samplings carried out during 1952, lake trout of the 8 to 12-inch length range represented 91 per cent of the total catch made by standard gangs of gill nets. Fish between 16 and 20 inches in length had dropped to 6.7 per cent in 1947.

In 1937, amphipods, chironomid larvae, and forage fish occurred in 34 per cent, 26 per cent, and 19 per cent, respectively, of the stomachs of lake trout examined. In 1943, 380 lake trout, of which 169 had food in their stomachs were examined. Chironomid larvae constitutes the main source of food of lake trout during their first years of life and as the trout grow, the importance of forage fish in their diet increases until it constitutes 100 per cent of the diet.

From the reported data and from a survey made through published studies of lake trout from various waters, it seems obvious that the problem concerning lake trout at Lake Minnewanka is related to the feeding habits of this fish since the construction of the dam in 1941. To improve conditions for lake trout, it seems desirable to introduce a species of fish closely associated with lake trout, utilized elsewhere by them for food, and not ecologically separated from the lake trout in the lake by depth or other environmental factors. Since the common whitefish seems to be the most logical food fish to plant in the lake, about one million and a half eyed eggs were planted in the lake during spring of 1953.

86. Berry, G. and P. A. Larkin. 1954. FIELD TRIALS WITH "FISH-TOX" IN STREAMS. The Canadian Fish Culturist, Issue 15, April, pp. 10-15.

In 11 trial poisonings, concentrations used ranged from 1 p.p.m. to 20 p.p.m. and times for application from 14 to 90 minutes. Concentrations of 1 and 2 p.p.m. did not effect complete kill, even when maintained for over an hour. More extensive kill was obtained with higher concentrations applied over short periods of 15 to 20 minutes. Increasing the application time to 30 minutes gave slightly greater distance of kill. As might be anticipated length of stream affected is related to concentration applied and rate of flow in the stream.

The following general practices were suggested in stream poisoning to ensure effective kill: (1) "Fish-tox" should be applied to provide a concentration of at least 4-5 p.p.m., and maintained for at least 15 minutes, (2) in small, slow-moving streams repeated application at one-quarter mile intervals is preferable, (3) in larger streams application points could probably be one mile apart, (4) poison can be conveniently applied by preparing a poison and water paste which is dispensed uniformly over the application period; and (5) where large fine-scaled or coarse-scaled suckers or carp are present, concentrations above 5 p.p.m. may be necessary to obtain a complete kill.

On the basis of the field trials the efficiency, cost and convenience of stream poisoning can readily be compared with the operation of coarse fish traps. First, poison kills resident stream fish in addition to spawning fish. Second, comparison of costs is strongly in favor of poisoning. Some apprehension is voiced by the public when larger numbers of trout are killed in addition to coarse fish. These problems imply the need for a public relations program and emphasize the importance of discretion in the use of poison.

87. Margolis, L. 1954. ULCER DISEASE AND FURUNCULOSIS IN A QUEBEC TROUT HATCHERY. The Canadian Fish Culturist, Issue 15, April, pp. 16-17.

The communication constitutes the first report of ulcer disease of trout (known to be caused by H. piscium) in Canada, and the first report of furunculosis in Eastern Canada. Fish of all ages in a trout hatchery in the Province of Quebec, were afflicted with ulcer disease at the time of examination in October 1952. All fish showing furunculosis were also afflicted with ulcer disease. It was believed that the disease was transmitted when yearling brook trout from a Northeastern United States hatchery were introduced into the ponds at the Quebec hatchery.

88. Berst, A. H. and J. W. Anderson. 1954. AERATOR FOR FISH HATCHERY TRANSPORT. The Canadian Fish Culturist, Issue 15, April, pp. 18-25.

This paper describes an aerator built by the authors and is accompanied by photographs and diagrams. The unit was built in March and April 1952 at a cost of less than $500. The system employed is the forcing of air through water to replenish the supply of dissolved oxygen to the water in the tanks.

89. MacKay, H. H. 1954. A DEVICE FOR THE CONTROLLED DRAINAGE OF HATCHERY TROUGHS. The Canadian Fish Culturist, Issue 15, April, pp. 26-27.

After feeding trout fry or fingerlings in hatchery troughs, it is necessary to remove waste by sweeping down the debris to the outlet without injury to the fish. To do this effectively it is necessary to lower the water in the troughs. Mr. T. Marston, Ontario, has devised a novel valve by which the flow of water against the screen may be regulated to minimize injury to the fish. A construction diagram with instructions are presented.

90. Smith, M. W. 1954. PLANTING HATCHERY STOCKS OF SPECKLED TROUT IN IMPROVED WATERS. The Canadian Fish Culturist, Issue 16, August, pp. 1-5.

The planting of hatchery-reared speckled trout, fingerlings and yearlings, to provide better angling was effective in Crecy Lake, New Brunswick, when conditions for growth and survival of trout in the lake were made more favorable by fertilization and predator control, and where the supply of naturally-reared young trout was insufficient to utilize an improved trout-carrying capacity. (A)

91. Ricker, W. E. 1954. PACIFIC SALMON FOR ATLANTIC WATERS? The Canadian Fish Culturist, Issue 16, August, pp. 6-13.

The commercial salmon fishery of the west Atlantic takes about 5 million pounds a year, as compared with about 150 million pounds in British Columbia and about 1,000 million pounds on the Asiatic side of the Pacific. The difference probably stems mainly from the fact that the two most numerous Pacific salmons live in rivers only during the spawning and incubation periods, and do not require the freshwater food or living space which appears to limit the supply of Atlantic salmon. Attempts at transplantation of Pacific salmon to other waters have only once been permanently successful—in New Zealand. However, Canadian effort along this line has been limited, and further trials would be warranted if the possibility of a major salmon industry in the east seems attractive to everyone concerned. (A)

92. Larkin, P. A. 1954. INTRODUCTIONS OF THE KAMLOOPS TROUT IN BRITISH COLUMBIA LAKES. The Canadian Fish Culturist, Issue 16, August, pp. 15-24.

The planting of Kamloops trout into barren lakes of British Columbia has provided opportunity for studying the most simple type of introduction, one in which a single species of fish is utilizing the food resources. Nevertheless, the results of the introductions have been so varied that there can be no doubt that this "simple" subject is highly complicated, and it is both difficult and misleading

to summarize "typical" results. Many of the introductions that have been attempted have failed to establish trout populations. These are a distinct failure by any criterion. Other introductions have resulted in the establishment of large populations of extremely small fish and while these were successes for the species, they remain failures to the fish culturist until remedial measures can be taken. The extent of natural spawning facilities is one of the most important factors in determining the nature of the fishery and the management problems it poses, but there are many other features of lake ecology which assume significance in local situations. The individuality of lakes predestines the singularity of their trout populations.

The fish culturist does not as yet have sufficient knowledge of the limnological and physiological requirements of Kamloops trout to make a rapid and inexpensive evaluation of the potentialities of a barren lake. In consequence, the cheaper and more direct alternative of experimental introduction is most frequently employed, despite the possibilities of failure.

The introduction of forage fish for Kamloops trout has emphasized the same principle. Despite the fact that some of the introductions were considered by trained men they did not develop as was expected and usually the results were unsatisfactory. Nevertheless, they have given some indications of the advisability of some types of management and in this respect alone could probably be justified. One might say that the lakes unfavorably affected were inadvertently sacrificed in a good cause.

It is concluded that the study of Kamloops trout in barren British Columbia lakes emphasizes the complexity of even simple aquatic communities, and thus the difficulty of predicting results of introductions of fish.

93. Neave, Ferris. 1954. INTRODUCTION OF ANADROMOUS FISHES ON THE PACIFIC COAST. The Canadian Fish Culturist, Issue 16, August, pp. 25-26.

Six plantings of shad fry, totalling 621,000, were made in the Sacramento River between 1871 and 1880. Further shipments amounting to 910,000 fry were planted in the Columbia River system in 1885-86. In 1879, 132 small striped bass were released in the "Delta" area of the Sacramento River. Another shipment of about 300 was planted in 1882.

It seems remarkable that these unprotected populations could find opportunities for such rapid expansion in such an unrestricted and presumably highly competitive ecological environment as the ocean. As far as is known their expansion has not been at the expense of other species, or at least of species in which man is economically interested. In some respects our ignorance of population dynamics is demonstrated as effectively by these successes as by the failures which have frequently attended our efforts to introduce species into new environments.

94. Hunter, J. G. 1954. A WEIR FOR ADULT AND FRY SALMON EFFECTIVE UNDER CONDITIONS OF EXTREMELY VARIABLE RUN-OFF. The Canadian Fish Culturist, Issue 16, August, pp. 27-33.

The enumeration of fry and adult migrants in a stream which was subject to severe flash floods, called for the construction of weirs capable of capturing the fish during severe floods as well as normal stream levels. These weirs were designed to be interchangeable on the same basic framework. This paper contains photographs and diagrams of the weirs.

95. McCrimmon, H. R. and O. E. Devitt. 1954. WINTER STUDIES ON THE BURBOT, LOTA LOTA LACUSTRIS, OF LAKE SIMCOE, ONTARIO. The Canadian Fish Culturist, Issue 16, August, pp. 34-41.

A study of Lake Simcoe burbot was made in January and February, 1954, during coarse fish removal operations when 2,813 burbot were captured. It was found that the otolith method offered the most satisfactory means of those investigated for the aging of burbot. A comparison with the growth rates of the burbot of lakes Opeongo and Erie revealed that the Lake Simcoe burbot grew faster than those of the other two lakes. The burbot of Lake Simcoe mature in their third and fourth years of life at lengths approximating 13 to 17 inches. The spawning period usually occurs during the last two weeks of January. It is believed that spawning areas are restricted largely to the open lake. The principal food items found in the burbot stomachs were the yellow perch, the freshwater herring and the emerald shiner. Other items such as the pumpkinseed, common white sucker, rock bass and crayfish occurred in lesser numbers. The burbot is seldom recognized as a food fish by the fishermen of Lake Simcoe. A commercial market for this species is lacking at the present time. (A)

96. Saunders, J. W. and M. W. Smith. 1954. THE EFFECTIVE USE OF A DIRECT CURRENT FISH SHOCKER IN A PRINCE EDWARD ISLAND STREAM. The Canadian Fish Culturist, Issue 16, August, pp. 42-49.

Electrofishing was carried out in Ellerslie Brook whose waters have a conductivity of 168 reciprocal mega-ohms at 25° C. The apparatus employed was a D.C. generator rated at 115 volts and 1200 watts. It was operated at 150 to 160 volts, with a load applied to give a total drain of 3 1/2 to 4 amperes. A high and consistent recovery of marked trout and young salmon was obtained. The value of electrofishing in making estimates of total populations in a small stream was demonstrated. (A)

97. Shapovalov, Leo and Alan C. Taft. 1954. THE LIFE HISTORIES OF THE STEELHEAD RAINBOW TROUT (SALMO GAIRDNERI GAIRDNERI) AND SILVER SALMON (ONCORHYNCHUS KISUTCH). Calif. Dept. of Fish and Game, Fish Bulletin No. 98.

This 375-page bulletin covers in detail the life histories of the silver salmon and steelhead rainbow trout. Information is well documented for migration, age and growth, sex ratio, egg production, development, sea life, homing and straying, survival, pathology, and food. Also discussed at some length are predators on both species. A section on management discusses regulations, habitat control, pollution, fish rescue and artificial propagation.

98. Bardach, John E. 1954. EFFECTS OF THE WIND ON WATER MOVEMENTS IN LAKE WEST OKOBOJI, IOWA. Proceedings of the Iowa Academy of Science, Vol. 61, pp. 450-457.

The effects of the wind on the water movements in Lake West Okoboji during the summer are described. Piling up of warm surface water and a depression of the isotherms in the thermocline were observed to occur at the downwind end of the lake. Under the influence of variable winds standing waves were set up with a period of 20-24 hours and an amplitude of 4-5 meters. Some biological implications of standing waves are discussed. (A)

99. Harrison, Harry M. and Everett B. Speaker. 1954. AN ANNOTATED LIST OF THE FISHES IN THE STREAMS TRIBUTARY TO THE MISSOURI RIVER IN IOWA. Proceedings of the Iowa Academy of Science, Vol. 61, pp. 511-523.

This paper is a report on the fishes collected in 17 streams draining the western and southern slopes of Iowa into the Missouri River. These streams include the Big and Little Sioux, Rock, Floyd, Ocheyedan, Otter, Soldier, Boyer, Maple, Willow, Plumb, Walnut, Nishnabotnas, Nodaway, Grand, 102 and Chariston Rivers. A total of 18 families represented by 74 species of fish are reported. (A)

100. Moen, Tom. 1954. FOOD OF THE BIGMOUTH BUFFALO, ICTIOBUS CYPRINELLUS (VALENCIENNES), IN NORTHWEST IOWA LAKES. Proceedings of the Iowa Academy of Science, Vol. 61, pp. 561-569.

Bigmouth buffalo, Ictiobus cyprinellus, have been commonly thought of as bottom feeders but data from the analysis of 259 buffalo stomachs taken from seven lakes during the period of 1946-53 indicate that they are predominately plankton feeders, taking principally small crustaceans (Entomostraca). Insect larvae, largely midge larvae, were taken frequently but seldom made up more than one per cent of the total volume of food in any one collection. Plant material in the food of buffalo was predominately blue-green algae of the genus Microcystis. Plant material seldom contributed more than 10 per cent of the volume of food organisms.

The winter food of buffalo consisted of 100 per cent entomostracans. Forty-three per cent of these stomachs contained food as compared with 80 per cent of the stomachs collected during the summer. The volume of food in each stomach was also less than that for summer collections.

Forty-eight stomachs from East Okoboji Lake buffalo (not included in the 259 reported here) collected in 1940 contained 90 to 95 per cent entomostracans with the remainder consisting of blue-green algae.

During the course of the study, 16 stomachs were checked for the total number of entomostracans. These figures ranged from 1,330 for young fish to 1,250,000 for adults and averaged 200,000 for fish taken during the summer and 8,600 for fish taken during the winter.

In trying to correlate plankton counts with the food found in the stomachs of buffalo taken at the same time, it appeared that buffalo were able to select nearly pure entomostracans in spite of the fact that blue-green algae was estimated to be 10 to 20 times more numerous. (A)

101. Rose, Earl T. 1954. BLUE-GREEN ALGAE CONTROL AT STORM LAKE. Proceedings of the Iowa Academy of Science, Vol. 61, pp. 604-614.

The copper sulfate treatment of Storm Lake during the summer of 1953 for the control of blue-green algae was planned originally to mitigate the danger of toxic algae which had prevailed during several previous seasons. Fortunately the toxic species, Anabaena flos-aquae did not develop this year; however, treatments were made to control heavy blooms of Aphanizomenon which, though not usually toxic, are potentially dangerous. Treatments were made by a specially designed power spray vessel and were confined to localized areas of heavy concentrations of algae. The effectiveness of the control program was assayed by counts of plankton organisms from seven representative stations on the lake. A special counting cell was devised that proved to be satisfactory in determining the abundance of plankton per unit volume. Bottom fauna and most entomostracans potential fish-food organisms, were apparently not adversely affected by the treatments. Some controlled experimental data were obtained that indicated danger to small fish in concentrations of copper sulfate slightly higher than are necessary to control algae. Also, the important fish-food crustacean, Daphnia, could not withstand the minimal dosage of 0.5 p.p.m.

102. Maupin, James K., James R. Wells, Jr. and Claude Leist. 1954. A PRELIMINARY SURVEY OF FOOD HABITS OF THE FISH AND PHYSICO-CHEMICAL CONDITIONS OF THE WATER OF THREE STRIP-MINE LAKES. Trans. Kans. Academy of Science, Vol. 57, pp. 164-171.

A comparative study was made of three strip-mine lakes in Crawford County, Kansas, locally known respectively as the Whitmer Pit, the North Jones Pit, and the South Jones Pit in order to: (1) Ascertain the physico-chemical condition of the water in which the fish of these lakes live; (2) make qualitative and quantitative studies of the benthic organisms in the lakes; and (3) determine the kinds and quantities of the benthic organisms being utilized as food by the centrarchid fishes inhabiting these lakes.

Whitmer Lake is comparatively old, being dug about fifty years ago with horse-drawn scrapers.

The North and South Jones Lakes are about twenty years old. Both are of the type formed by the most modern methods of strip mining.

The findings of this study lead to the following conclusions: The 20-year old lakes have about the same physico-chemical characteristics as the 50-year old one and these characteristics are within the limits of a thriving warm-water fish population. The number and volume of benthic organism in Whitmer Lake and South Jones Lake are an indication that they should have a fairly high productivity, but that North Jones Lake falls short in this respect. The benthic organisms are not the primary source of food for fish, probably due to one or a combination of factors, to wit: (1) They are not readily available to fishes as food, (2) fishes eat only food that is readily available, and (3) species not benthic are preferred food by fishes if available.

103. Schoonover, Roy and William H. Thompson. 1954. A POST-IMPOUNDMENT STUDY OF THE FISHERIES RESOURCES OF FALL RIVER RESERVOIR, KANSAS. Trans. Kans. Academy of Science, Vol. 57, pp. 172-179.

This survey proposed to investigate the development of fish populations of Fall River Reservoir. While interim storage occurred in 1948, final storage did not begin until 20 April 1949. Significant numbers of white crappie, drum, smallmouth buffalo, and channel catfish of the 1949 year-class were collected. Those species which apparently made their appearance in large numbers a year later (1950) included bullhead, largemouth bass, and carp. No black crappie of a year-class prior to 1951 were collected. To date, smallmouth buffalo appeared to have had its best spawning year in 1949. Carp had its best year in 1950. However, before it can be determined that rough fish such as the latter two mentioned species will not be problem fishes, further surveillance will be necessary in the next few years. Crappie, channel catfish, and largemouth bass have not yet reached their peak in development.

Generally, the fisheries resources of Fall River Reservoir could be utilized to a much greater extent than has been the case to date.

104. Cross, Frank B. 1954. FISHES OF CEDAR CREEK AND THE SOUTH FORK OF THE COTTONWOOD RIVER, CHASE COUNTY, KANSAS. Trans. Kans. Academy of Science, Vol. 57, pp. 303-314.

The smaller streams of the Flint Hills Region in east-central Kansas are inhabited by fishes of both the Plains and the Ozarkian faunas. Species collected from two of these streams, the South Fork of the Cottonwood River and Cedar Creek are discussed in this paper with an annotated list of the species.

105. Cross, Frank B. 1954. RECORDS OF FISHES LITTLE-KNOWN FROM KANSAS. Trans. Kans. Academy of Science, Vol. 57, pp. 473-479.

This paper presents distributional records and other notes upon ten species of fishes which have seldom or never been reported from Kansas.

106. Dineen, Clarence F. and Paul S. Stokely. 1954. OSTEOLOGY OF THE CENTRAL MUDMINNOW, UMBRA LIMI. Copeia, No. 3, pp. 169-179.

The vagaries of the relationships of the central mudminnow, Umbra limi (Kirtland), together with the spotty distribution of its relatives in the family Umbridae, prompted us to carry out as complete a study of the species as was practicable. A statistical analysis of the growth of the mudminnow revealed that some allometry did occur, although of small magnitude (Stokely and Dineen, 1953). Work is in progress on the ecological aspects of the life history of this fish.

This report is based upon 26 cleared and stained specimens (Davis and Gore, 1936) ranging in standard lengths from 30 to 115 mm. that were collected during the summer and fall of 1952 from Judy Creek, just north of the campus of the University of Notre Dame. (A)

107. Witt, Arthur, Jr. and Richard C. Marzolf. 1954. SPAWNING AND BEHAVIOR OF THE LONGEAR SUNFISH, LEPOMIS MEGALOTIS MEGALOTIS. Copeia, No. 3, pp. 188-190.

The spawning activities of the longear sunfish, Lepomis megalotis megalotis (Rafinesque), have been described only in a general way, in spite of the common occurrence of this species.

This paper presents observations on the spawning activity and behavior of the longear sunfish as observed between June 13 and 19, 1951, at the mouth of the Little Niangua River, Lake of the Ozarks, Missouri.

108. Rough, Gaylord E. 1954. THE FREQUENCY RANGE OF MECHANICAL VIBRATIONS PERCEIVED BY THREE SPECIES OF FRESHWATER FISH. Copeia, No. 3, pp. 191-194.

Considering the sounds which are a normal part of the environment of fishes, the extent of the range of frequency perceived, as reported in previous investigations, seems narrow. An attempt has therefore been made to determine more fully and accurately the limits of perception of some common freshwater fishes. The perception of Cyprinus carpio was found to be effective within the frequency range of 8 to 22,000 cycles without any discreet points of greater or lesser sensitivity.

In the present study it was decided to employ the learning or conditioning method as previously used by Froloff (1925), Bull (1928), and others, but with several new techniques and apparatus which were believed necessary to correct the inadequacies of previous studies.

It was not possible to develop a conditioned response to vibratory stimuli in Umbra limi because of the inability of this species to perceive the stimuli, or its inability to form associations. The range of perception could therefore not be determined by the method of conditioning with active swimming as the criterion for positive response.

A conditioned response was developed in Ameiurus nebulosus, but because of a high rate of mortality among the subjects a determination of the range

or perception of vibratory stimuli was not completed. This species was capable of perceiving vibrations of 910 cycles with certainty.

109. Strawn, Kirk. 1954. THE PUSHNET, A ONE-MAN NET FOR COLLECTING IN ATTACHED VEGETATION. Copeia, No. 3, pp. 195-197.

The pushnet, apparently unknown to most ichthyologists, is an efficient one-man net for collecting in shallow water and in attached aquatic vegetation, including cattails. Its operation is identical to that of a man-powered lawn mower, with the same ease of control and maneuverability. It operates much like a trawl but can be used in shallower water and its course is easier to control. A seine dragged in heavy vegetation tends to ride high off the bottom and to roll up, whereas the leading edge of a pushnet in the same situation stays on the bottom and the webbing remains fully spread from the start to the end of a "push." Operating a pushnet in heavy vegetation is much less fatiguing than using a seine.

A description and diagram of the construction of the pushnet are given.

110. Miller, Robert Rush. 1954. THE SOUTHERN LIMIT OF THE GARFISHES, FAMILY LEPISOSTEIDAE. Copeia, No. 3, 230-231.

This paper presents information to clarify the distributional limits of the garfish.

111. Bacon, Edward H. 1954. FIELD CHARACTERS OF PROLARVAE AND ALEVINS OF BROOK, BROWN AND RAINBOW TROUT IN MICHIGAN. Copeia, No. 3, pp. 232.

This brief paper presents information to aid in identification of young trout up to 1 1/2 inches in length. A photograph aids in this identification.

112. Lievense, Stanley J. 1954. SPAWNING OF AMERICAN SMELT, OSMERUS MORDAX, IN CRYSTAL LAKE, BENZIE COUNTY, MICHIGAN. Copeia, No. 3, pp. 232-233.

This paper presents data on smelt spawning on lake shores.

113. Crawford, Ronald W. 1954. STATUS OF THE BRONZE DARTER, HADROPTERUS PALMARIS. Copeia, No. 3, pp. 235-236.

From data gathered it appears that Hadropterus palmaris is a stable species in its range. If intraspecific variation were present, it would most likely have appeared when specimens from the extremes of the range were examined.

114. Marcy, Donald E. 1954. THE FOOD AND GROWTH OF THE WHITE CRAPPIE, POMOXIS ANNULARIS, IN PYMATUNING LAKE, PENNSYLVANIA AND OHIO. Copeia, No. 3, pp. 236-239.

The growth of fishes varies markedly in different regions because of different climatic and other environmental conditions. Because of its separation into three more-or-less distinct parts, Pymatuning Lake offers a unique opportunity to study the effect on fish growth of different ecological conditions in adjoining bodies of water with the same water supply. The aims of the investigation were to compare the growth of Pymatuning Lake white crappies with that of the species in other waters, and to compare the food and growth of the white crappie in the three parts of Pymatuning Lake.

Limited observations were made on the food of white crappies. The stomach contents of 105 individuals were examined. Among smaller individuals the most common food item was Cladocera; Copepoda were next most common. Notonecta, Chironomus larvae and adults, and unidentifiable insect fragments were also found in stomachs of small individuals.

Larger individuals were found to have eaten fishes almost exclusively, including carp, perch, bluegill, other white crappies, and gizzard shad. A few invertebrates, chiefly Chironomus larvae and adults, were found.

Total-length measurements of 472 white crappies from all three divisions of Pymatuning Lake were combined for comparison with growth in other waters.

From age group II to age group VII white crappies in Middle Lake exceeded the average total length of fish from the other two divisions by differences ranging from 8 mm. to 35 mm. The test of significance gave the variance ratio, F, equal to 6.25, indicating high significance at the 1 percent level of confidence in Fisher's table of distribution of F (Snedecor, 1950).

If the differences in fishing pressure were responsible for the difference in growth rates, then according to present beliefs (Langlois, 1939, Ohio Conserv. Bull., 3 (1):16-7) growth should be best in Lower Lake and poorest in Sanctuary Lake. Since this was not the case it is assumed that differences in fishing pressure were not great enough to be effective. With the information at present available it is only possible to suggest that the moderate depths of Middle Lake, together with the extensive stump areas and optimum fishing pressure, provided the most favorable conditions for white crappies. That young-of-the-year had the longest average total length in Sanctuary Lake suggests that the abundant plankton population and relatively large amount of shallows had a favorable influence on the growth of young white crappies.

115. Morton, William Markham and Robert Rush Miller. 1954. SYSTEMATIC POSITION OF THE LAKE TROUT, SALVELINUS NAMAYCUSH. Copeia, No. 2, pp. 116-124.

In conclusion, this paper states that: (1) A number of characters readily distinguish S. namaycush from all other members of the genus. The best of these, we believe, are color pattern, dorsal-fin position, the deeply forked caudal fin, and the large number of pyloric caeca. (2) The supposedly key generic character, a crested vomer, is found in other species of the genus Salvelinus and is not developed consistently in the lake trout. None of the other distinguishing characters of this species is regarded by us to be of generic value. (3) The species namaycush manifests very clearly all of the essential

characters of Salvelinus, which we believe to be a recognizable genus. (4) Therefore we support the recent trend among American ichthyologists to suppress the genus Cristivomer as a synonym of Salvelinus. (A)

116. Weisel, George F. and John B. Dillon. 1954. OBSERVATIONS ON THE PYGMY WHITEFISH, PROSOPIUM COULTERI, FROM BULL LAKE, MONTANA. Copeia, No. 2, pp. 124-127.

It is well known that members of Coregonidae are a plastic group. A single species may vary considerably under different environmental conditions and separate races may exist in the same habitat. Many forms previously considered to be valid species have been reduced to synonomy (Monti, 1931; Dymond, 1943; Kennedy, 1953). One of the variations they exhibit is a form of dwarfism in which the fish are not only smaller but mature earlier and have a shorter life span (Klunzinger, 1900; Kennedy, 1943).

Prosopium coulteri is considerably smaller than P. williamsoni of the same age; has fewer scales, fin rays, and gillrakers; and may mature a year earlier. From existing data, it is not improbable that its life span never approaches the nine or ten years of P. williamsoni. It may be considered a dwarf whitefish, but not in the sense that it is just a variation within the species P. williamsoni. In the first place, it is markedly different from the mountain whitefish in the shape of its head, its meristic characters, and in many of its proportions. Furthermore, it cohabits with the mountain whitefish, yet no intergrades or hybrids between the two have been described; and although it is rarely caught, it covers a fair geographic range. (A)

117. Hall, Gordon E. and George A. Moore. 1954. OKLAHOMA LAMPREYS: THEIR CHARACTERIZATION AND DISTRIBUTION. Copeia, No. 2, pp. 127-135.

The two Oklahoma lampreys, Ichthyomyzon castareus and I. gagei are compared in distribution, habitat, and characteristics.

118. Roelofs, Eugene W. 1954. FOOD STUDIES OF YOUNG SCIAENID FISHES, MICROPOGON AND LEIOSTOMUS, FROM NORTH CAROLINA. Copeia, No. 2, pp. 151-153.

Analysis of the food habits of 159 croakers, Micropogon undulatus and 73 spot, Leiostomus xanthurus is presented. Observations on feeding habits were made in aquaria.

119. Ingram, William Marcus and G. W. Prescott. 1954. TOXIC FRESH-WATER ALGAE. Am. Midland Naturalist, Vol. 52, No. 1, July, pp. 75-87.

Outbreaks of human gastroenteritis have not been positively traced to algae. Algae that have been responsible for mammalian, avarian, and fish deaths through some toxic action are all to be found in the blue-green algal group, the Cynapophyta. The Cyanophyta species that have been associated with animal deaths belong in the genera: Microcystis, Aphanizomenon, Anabaena, Nodularia, Coelosphaerium, and Gloeotrichia.

Often when deaths of animals occur, a wind has been reported blowing, thus tending to concentrate algae in lee-shore areas.

Cattle that drink only small quantities of water containing Microcystis may not die but do show a series of illness symptoms, one of which is a drop in milk yield.

Symptomatic treatment has been recommended by Steyn (1945) for cattle poisoned by algae.

Various writers have made reference to several toxic substances associated with blue-green algae.

Substances that are toxic enough to cause illness or death in animals are not present in all blue-green algae.

Water in which certain blue-green algae have bloomed may produce death in mammals and fish when the algal cells themselves are excluded.

The toxic material from certain algae may survive the laboratory equivalent of water treatment, using alum coagulation, filtration and chlorination. It may survive activated carbon treatment in amounts corresponding to that used in water treatment plants, and after massive treatment with Norite A. (A)

120. Hubbs, Carl L. and John D. Black. 1954. STATUS AND SYNONYMY OF THE AMERICAN PERCID FISH HADROPTERUS SCIERUS. Am. Midland Naturalist, Vol. 52, No. 1, July, pp. 201-210.

There has been much disagreement in regard to the characters, classification, and nomenclature of the American darters described as Hadropterus scierus Swain (1883:252), as H. scierus serrula Jordan and Gilbert (1886:16), and as H. maxinkuckiensis Evermann (1900a:366). The questions involved have therefore been subjected to inquiry, and the findings are presented.

121. Hubbs, Clark. 1954. A NEW TEXAS SUBSPECIES, APRISTIS OF THE DARTER HADROPTERUS SCIERUS, WITH A DISCUSSION OF VARIATION WITHIN THE SPECIES. Am. Midland Naturalist, Vol. 52, No. 1, July, pp. 211-220.

In this paper a new subspecies of darter from Texas is described, its ecology is discussed briefly, and a study is presented of the geographical variation exhibited by Hadropterus scierus, especially in Texas and Oklahoma. (A)

122. O'Donnell, D. John and Warren S. Churchill. 1954. CERTAIN PHYSICAL, CHEMICAL AND BIOLOGICAL ASPECTS OF THE BRULE RIVER, DOUGLAS COUNTY, WISCONSIN. (Brule River Survey Report No. 11). Trans. Wisc. Academy of Sciences, Arts and Letters, Vol. XLIII, Sept., pp. 201-255.

The first ten publications on the Brule River Survey were concerned each with a specific major phase of the investigation. These included detailed reports on the history of fishing, vegetation of the watershed, aquatic plants, parasites of the Brule fishes, vegetative cover, the brook lamprey and others. The present paper is the final one of the series and includes sections on a number of the physical, chemical and biological aspects, such as, anchor ice, fishes and populations, movement of fishes, spawn-

ing areas, food of fishes, chemistry and others. An aerial guide is included as an appendix indicating all check points. (A)

123. Loukashkin, Anatole S. and Norman Grant. 1954. FURTHER STUDIES OF THE BEHAVIOR OF THE PACIFIC SARDINE (SARDINOPS CAERULEA) IN AN ELECTRICAL FIELD. Proc. Calif. Academy of Sciences, Vol. 28, No. 6, pp. 323-337.

In view of the widespread use of electrical collecting methods, this paper is reviewed although it deals with a non-sport fish.

The five types of pulsating direct current wave forms used by the experimenters are effective in producing forced directional swimming of the Pacific sardine (Sardinops caerulea) and also the jacksmelt (Atherinopsis californiensis), and the topsmelt (Atherinops affinis) that were used as controls.

All wave forms tested can produce full (+ +) control of fish movements and force them to the positive pole where they can be held until the current is turned off.

The electrically stimulated reactions can be obtained and will remain constant if a proper optimal range of average current density is determined for each particular species and size.

Current density is the most critical factor in producing forced directional swimming and control of fish movements.

Average current densities above the optimal range may cause temporary paralysis or even death of the fish whereas those below produce a slight directional response or none at all.

The optimal average current density required to produce "satisfactory" directional swimming and controlled (+ +) movement of fish appears to vary inversely with the size of the fish.

Full control of fish movement and forced directional swimming can be obtained with any frequency of current pulsation from 2 to 80 per second; the frequencies above 80, however, have not been tested.

The use of a pulse frequency as high as 60 to 80 per second reduced the optimal average current density to 50 per cent of the amount required at a frequency of 5 per second.

The most effective and "satisfactory" results as far as the smoothness of performance and school coordination are concerned, were recorded when either continuous or interrupted half-wave rectified 60-cycle alternating current was used.

Condenser discharge pulse produced the "satisfactory" reactions at very low average current densities (0.4 to 0.8 milliampere). This represents a substantial decrease in power requirements. (A)

124. Wolf, Ken. 1954. PROGRESS REPORT ON BLUE-SAC DISEASE. Progressive Fish-Culturist, Vol. 16, No. 2, April, pp. 51-59.

After a severe outbreak of the blue-sac disease in lake trout fry, investigations were started to determine the incidence, cause, and cure or prevention of the disease. To date more than 250 experiments have been completed. This report covers the results obtained from these experiments.

125. Schoffman, Robert J. 1954. AGE AND RATE OF GROWTH OF THE CHANNEL CATFISH IN REELFOOT LAKE, TENNESSEE. J. Tenn. Academy of Science, Vol. 29, No. 1, January, pp. 2-8.

A study of the age, growth and size distribution of the channel catfish, Ictalurus lacustris punctatus, in Reelfoot Lake was undertaken by use of sections from the pectoral spine. Age groups I through VIII were found in the 421 specimens. Length-weight relationship showed a slow rise until a length of 16 inches was attained. Thereafter, the weight increased rapidly. Channel catfish showed a rapid growth and are being harvested during their period of rapid growth.

126. Carranza, Jorge and Howard Elliott Winn. 1954. REPRODUCTIVE BEHAVIOR OF THE BLACKSTRIPE TOPMINNOW, FUNDULUS NOTATUS. Copeia, No. 4, pp. 273-278.

Observations on the reproductive habits of the Blackstripe topminnow were made during June and July 1953 at Whitmore Lake, Michigan and in aquaria. Sexual dimorphism, spawning season, territoriality and display, courtship and spawning are described. Also a comparison of breeding behavior between F. notatus and F. heteroclitus is given.

127. Weisel, George F. 1954. A REDISCOVERED CYPRINID HYBRID FROM WESTERN MONTANA, MYLOCHEILUS CAURINUM X RICHARDSONIUS BALTEATUS BALTEATUS. Copeia, No. 4, pp. 278-282.

Taxonomic description of the hybrid and comparisons with the parent stocks are made.

128. Bailey, Reeve M. 1954. DISTRIBUTION OF THE AMERICAN CYPRINID FISH HYBOGNATHUS HANKINSONI WITH COMMENTS ON ITS ORIGINAL DESCRIPTION. Copeia, No. 4, pp. 289-291.

A description of the lectotype of H. hankinsoni is given together with a discussion of its distribution including a map.

129. Rupp, Robert S. and Marvin C. Meyer. 1954. MORTALITY AMONG BROOK TROUT, SALVELINUS FONTINALIS, RESULTING FROM ATTACKS OF FRESHWATER LEECHES. Copeia, No. 4, pp. 294-295.

During July 1953, an unusual mortality of brook trout occurred at Quimby Pond, Maine. Numbers of trout were gathered in spring holes to avoid the warmer water of the pond and were being attacked by hordes of Macrabdella decora and Haemopis grandis. Small wounds on dead trout showed where leeches had fed. One fish taken in dying condition had had a leech bore through the body wall and into the ventral aorta. The color of the liver was creamy white. It was apparent the fish was dying from loss of blood.

130. Cobb, Eugene S. 1954. THE USE OF FISH TRAPS IN THE MANAGEMENT OF FARM PONDS.

J. of Tenn. Academy of Science, Vol. 29, No. 1, January, pp. 45-54.

Traps producing the highest yields in these experiments were constructed of welded wire having one-inch mesh which permitted a high degree of visibility on the inside of the trap. The bait in the traps producing the highest yields was near enough to the mouth of the trap so that fish encountered little difficulty in finding their way into the traps. The funnel openings of traps producing highest yields in the experiments were adjusted in such a way that fish of the desired size could not easily escape after having entered the trap. Greater numbers and larger weights of bluegills were caught with soybean cake than with cottonseed cake, bread or Doodle-oil. All baits producing good catches were of such a consistency that they slowly disintegrated into small particles when in water and were readily eaten by bluegills. Baited traps were highly effective in removing large numbers of bluegills from ponds in relatively short periods of time. The average catch per trap varied directly with the density of the population at the time of trapping and inversely with the number of traps used.

The trapping of large numbers of bluegills during relatively short periods in the summer and early fall resulted in heavy reproduction of bluegills in all ponds. The corresponding increase in the percentages of small fish indicated that intensive trapping during these seasons in poorly balanced ponds could easily lead to overcrowded bluegill populations. (A)

131. Parsons, John W. 1954. THE FISH SPECIES COMPOSITION AND CHEMICAL AND PHYSICAL FEATURES OF A SEVENTY-TWO ACRE RESERVOIR IN TENNESSEE. J. Tenn. Academy of Science, Vol. 29, No. 1, January, pp. 55-65.

The McMinnville City Reservoir is located on the Barren Fork River at the outskirts of McMinnville in Warren County, Tennessee. The reservoir surface area is 72 acres, volume 1060 foot acres, average depth 13.2 feet, length 4.1 miles and maximum width 360 feet. Water temperatures, pH, turbidity, hardness and alkalinity data were compiled for the years 1940 to 1952. The annual mean water temperature for the reservoir was 61° F., pH 7.6, alkalinity 73 p.p.m., hardness 75 p.p.m., and turbidity 60 p.p.m. High average turbidities occurred during the summer months from 1940 to 1952 and was lowest during October. The degree of turbidity apparently is regulated by rainfall, erosion, water temperature, and carp activity.

Total water displacement in the reservoir may take place within a 24-hour period in the winter and within a few days in the summer months.

On September 13, 1952, toxic chemicals were applied to the reservoir waters in an attempt to kill all fish. A total of 20,410 fish weighing 7,753.8 pounds were recovered after the chemical treatment. The reservoir contained 122.3 pounds of fish per acre of which 10.4 pounds, including bullheads, were catchable sized game fish. Largemouth bass and bullheads were the most important catchable sized fish by weight. Rough fish constituted 83.9 percent of the total fish weight, forage fish 2.7 percent, and game fish 13.4 percent. Small fish and young-of-the-year fish were relatively uncommon.

There was no evidence that the chemicals or dead fish affected the city water supply at any time.

Compared to other lakes of similar or different types, the McMinnville City Reservoir had a low fish population by weight.

Channel catfish, largemouth bass, bluegills, and threadfin shad have been stocked in the reservoir following the fish eradication.

132. Pollak, M. J. 1954. THE USE OF ELECTRICAL CONDUCTIVITY MEASUREMENTS FOR CHLORINITY DETERMINATION. J. of Marine Res., Vol. 13, No. 2, Nov., pp. 228-231.

Limitations in our knowledge of the electrical conductivity of sea water are discussed. An empirical equation is presented which gives chlorinity as a function of specific conductance and temperature at atmospheric pressure. (A)

133. Miller, Joseph Henry. 1954. STUDIES ON THE LIFE HISTORY OF POSTHODIPLOSTOMUM MINIMUM (MacCALLUM 1921). J. of Parasitology, Vol. 40, No. 3, June, pp. 255-270.

The first carefully controlled experimental life history of Posthodiplostomum minimum from cercaria to adult is reported.

Physa heterostropha may serve as the first intermediate host. Evidence is given for the passive transfer of metacercariae via the circulatory system to loci of development in Lepomis gibbosus and Lepomis megalotus. A description of this development is given. Adults are obtained in 32 hours after feeding metacercaria to young chicks. Eggs shed by these worms did not undergo development. The adults developing in chicks from these metacercariae are identical morphologically with the type specimens and descriptions of P. minimum (Mac Callum, 1951) Dubois, 1936.

134. Dickerman, E. Eugene. 1954. PAURORHYNCHUS HIODONTIS, A NEW GENUS AND SPECIES OF TREMATODA (BUCEPHALIDAE: PAURORHYNCHINAE N. SUBFAM.) FROM THE MOONEYE FISH, HIODON TERGISUS. J. of Parasitology, Vol. 40, No. 3, June, pp. 311-315.

A new genus and species of gasterostome, Paurorhynchus hiodontis is described from the body cavity of the Mooneye fish, Hiodon tergisus, and placed in the newly created subfamily, Paurorhynchinae, in the family Bucephalidae.

The new trematode differs from all other described species of bucephalids in being considerably larger, in being spineless, in having lobed gonads and by living in the body cavity of the host.

The miracidium is of the bucephalid type, but differs in having five ciliated plates instead of four and two pairs of unjointed appendages instead of three pairs of jointed ones.

135. Guilford, Harry G. 1954. PARASITES FOUND IN THE SEA LAMPREY, PETROMYZON

MARINUS, FROM LAKE MICHIGAN. J. of Parasitology, Vol. 40, No. 3, June, p. 364.

During the years 1951 and 1952, 76 mature sea lampreys were examined for parasites. Twelve of these were active feeders taken in February from nets set in Lake Michigan near Sturgeon Bay, Wisconsin. Sixty-five were upstream migrants taken in June in Hibbards Creek and the Kewaunee River, tributaries of Lake Michigan in Door and Kewaunee Counties, Wisconsin, respectively. All were examined while fresh and the parasites living. Five of the 12 actively feeding lampreys and 36 of the 65 upstream migrants were infected with helminth parasites. No more than 2 species of helminths were found in 1 host. All were confined to the alimentary canal. No pathological disturbances were associated with any of the parasites. The parasite most frequently encountered was Proteocephalus exiguus LaRue.

136. Self, J. Teague. 1954. PARASITES OF THE GOLDEYE, HIODON ALOSOIDES (RAF.), IN LAKE TEXOMA. J. of Parasitology, Vol. 40, No. 4, August, pp. 386-389.

The goldeye (Hiodon alosoides) in Lake Texoma, harbors large numbers of the cestode Bothriocephalus texomensis n. sp. and the trematode Crepidostomum illinoiense.

The newly described cestode is most closely related to B. cuspidatus Cooper, differing from the latter in the nature of the scolex, the number, size, and arrangement of the vitellaria, the failure of the cirrus to protrude, and the smaller number of subsegments formed. The specific diagnosis of C. illinoiense is expanded to describe the variations between relaxed and contracted conditions. (A)

137. Iversen, Edwin S. 1954. A NEW MYXOSPORIDIAN, MYXOSOMA SQUAMALIS, PARASITE OF SOME SALMONOID FISHES. J. of Parasitology, Vol. 40, No. 4, August, pp. 397-404.

A new species of myxosporidian parasite Myxosoma squamalis, from rainbow trout, silver salmon, and chum salmon, is described. This parasite in the trophozoite stage apparently attacks the surface of the scales of these fish and in some manner forces its way inside the scales and sporulates.

It is believed that as a result of the infection the epithelial layers and the fibroblasts of the scale pocket are modified in an area closely associated with an infected scale. That the parasite is a cause of mortality in the host fish in not known.

Measurements and a description of fresh spores are given, as well as measurements of spores fixed in formalin and stained in Giemsa. A substantial shrinkage was noted as a result of the fixing and staining. The size of the trophozoite varies with the size of the scale. Fresh sporonts are described, and these may contain 1 or 2 developing spores. (A)

138. Haley, A. James. 1954. FURTHER OBSERVATIONS ON GLUGEA HERTWIGI WEISSENBERG 1911, 1913 (MICROSPORIDIA) IN FRESH WATER SMELT IN NEW HAMPSHIRE. J. of Parasitology, Vol. 40, No. 4, August, pp. 482-483.

Because of its high value as a forage and food fish the restricted natural distribution of the fresh water smelt, Osmerus mordax (Mitchell), in New Hampshire has been greatly extended by transplantation. Each year during the spring spawning runs large quantities of smelt and smelt eggs are collected from Lake Winnisquam and distributed to other bodies of water throughout the State. During the late winter and spring of 1952, 910 smelt from Winnisquam were examined of which 86 (9.5 percent) were found infected with Glugea hertwigi. Examination of nearly 500 smelt from several other localities, whose smelt populations were established from Winnisquam stock, showed the disease to be present in 7 additional lakes and ponds.

139. Wagner, Edward D. 1954. THE LIFE HISTORY OF PROTEOCEPHALUS TUMIDOCOLLUS WAGNER, 1953 (CESTODA), IN RAINBOW TROUT. J. of Parasitology, Vol. 40, No. 5, sec. 1, October, pp. 489-498.

Several species of copepods may serve as intermediate hosts for Proteocephalus tumidocollus, viz. Cyclops vernalis, Eucyclops agilis, E. speratus and Tropocyclops prasinus. Two other species of cyclops, some daphnia, ostracods and a fairy shrimp were tested with negative results.

Development of tapeworm larvae within cyclops was affected by temperature. The optimal temperature was about 20° C., and growth was inhibited almost entirely at 1° C. However, when cyclops harboring undeveloped larvae for 40 days at 1° C. were transferred to 20° C., normal larval growth occurred. Procercoid larvae became infective to fish as early as 9 days after the cyclops were fed tapeworm eggs. The highest rates of infection in fish were obtained when cyclops infected for 15 to 19 days were fed to the fish. No second intermediate host is requred for the completion of the life cycle. However, when small infected fish were fed to large trout, the tapeworms were successfully transferred from fish to fish.

140. Cohen, Daniel M. 1954. AGE AND GROWTH STUDIES ON TWO SPECIES OF WHITEFISHES FROM POINT BARROW, ALASKA. Stanford Ichthyological Bulletin, Vol. 4, No. 3, August, pp-168-187.

Two species of coregonine fishes, Coregonus nasus kennicotti Milner and Coregonus sardinella (Valenciennes) were collected in the area of Point Barrow, Alaska. Coregonus nasus kennicotti was taken from fresh-water Ikroavik Lake. Coregonus sardinella was taken in Ikroavik Lake and in the brackish inlet.

Coregonus nasus kennicotti spawns in July or earlier in Ikroavik Lake. The eggs take from 30 to 60 days to hatch rather than the 100 to 150 days more common in other coregonine fishes. The reason for the more rapid hatching may be that the lake experiences its peak temperatures during the spawning and hatching period. To obtain the true age of C. n. kennicotti it is necessary to add one to the number of annuli as the first annulus is not laid down till the end of the second year. The body-length antero-lateral scale-length relationship was deter-

mined.

Coregonus sardinella populations were divided into three groups on the basis of the structure of the scales. Two groups were taken in Ikroavik Lake. One of them, called "F" type, had the annuli marked by wide clear bands. The other group, called "X" type, had the annuli marked by an extreme crowding together of the circuli. A third group consisted of fishes taken for the most part in brackish water. These fish, which had evenly spaced circuli, and annuli with no clear bands, were called type "M".

Spawning of C. sardinella in Ikroavik Lake takes place in September. Hatching occurs under the ice. The fish are between 54 and 60 mm. in fork length when scales form in the area between the lateral line and the anterior edge of the dorsal fin, where scale samples were taken. To obtain the correct age of sardinella, it is necessary to add one to the number of annuli.

There seems to be some correlation between average annual growth increments and average Point Barrow air temperatures for "X" type and "F" type fish. There is none in "M" type fish.

The fresh-water fish of the area are few and slow growing. The possibility of a major commercial fishery seems improbable.

141. Wohlschlag, Donald E. 1954. GROWTH PECULIARITIES OF THE CISCO, COREGONUS SARDINELLA (VALENCIENNES), IN THE VICINITY OF POINT BARROW, ALASKA. Stanford Ichthyological Bulletin, Vol. 4, No. 3, August, pp. 189-209.

A study of the growth characteristics of the cisco, Coregonus sardinella, taken from a marine coastal estuary and from fresh-water Ikroavik Lake in the vicinity of Point Barrow, Alaska, revealed major growth differences between fish from the two environments and among the fish within the lake. A fairly good linear representation of length-weight relationships may be obtained by plotting the log weights in grams (W) against the log fork lengths in millimeters (L) for fish whose fork lengths are 180 millimeters or more.

Lake fish had very large amounts of viscerally accumulated fat, while the estuary fish did not. Not only are the lake fish heavier, but length for length they are progressively heavier with a high degree of statistical significance.

The possible causes of differences in body from among the ciscoes are discussed with reference to the environmental differences which exist among lakes, streams, and marine or brackish coastal waters in the Arctic. Major environmental differences exist for salinity, temperature, space, light, and food factors, which could affect either or both embryological development and later growth. For most of these factors, except salinity, the stream environments would be expected to be the most variable.

142. Davis, Charles C. 1954. A PRELIMINARY STUDY OF THE PLANKTON OF THE CLEVELAND HARBOR AREA, OHIO. (II. The Distribution and Quantity of the Phytoplankton.) Ecological Monographs, Vol. 24, No. 4, October, pp. 321-347.

From September 1950 through September 1951, quantitative plankton samples were obtained at the surface and at 6.5 m. approximately every two weeks at 9 stations in the Cleveland Harbor area of Lake Erie. The numbers of cells, numbers of coenobia, and volumes/l were determined for the phytoplankters.

Total volumes/l of the phytoplankton showed characteristic autumnal and vernal maxima, and winter and summer minima. Comparisons showed that the phytoplankton productivity as measured in the western basin of Lake Erie, was far higher than shown by the present results for the central basin. Similar quantitative comparisons with the eastern basin were not feasible on the basis of existing data.

The decrease in quantity of phytoplankton from the vernal pulse to the summer minimum was very sudden, and occurred in the first few days of June.

Diatoms constituted nearly 100 percent of the phytoplankton of the winter and spring seasons. Diatoms also dominated during the summer and fall, but blue-green and green algae became relatively more important.

Nine categories (species or genera) of Cyanophyta, 11 categories of Diatomaceae, 16 categories of Chlorophyta and 7 categories of "holophytic Mastigophora" are considered in detail. The observed seasonal distribution of each is given, and graphs and tables are given for the more abundant kinds.

143. Wilimovsky, Norman J. 1954. LIST OF THE FISHES OF ALASKA. Stanford Ichthyological Bulletin, Vol. 4, No. 5, December, pp. 279-294.

An extensive list of Alaskan fishes containing a number of new records and extensions of previously known ranges, as well as some major nomenclatorial changes.

144. Tanner, Vasco M. 1954. SMALL CLAM ATTACKS YOUNG TROUT. The Great Basin Naturalist, Vol. 14, Nos. 1-2, August, pp. 23-25.

In February 1954, more than 100 rainbow trout fry at the White Rocks State Fish Hatchery, Uinta County, Utah, were found to have an enlargement on their lower lip which precluded their feeding. The young fish, which averaged 32 mm. in length, were being attacked by adults of Pisidium variable Prime. The Pisidia fastened on to the lower lip when the mouth was open. Once attached, it was impossible for the fish to feed. The lower lip was gradually digested.

145. Bailey, Reeve M., Howard Elliott Winn, and C. Lavett Smith. 1954. FISHES FROM THE ESCAMBIA RIVER, ALABAMA AND FLORIDA, WITH ECOLOGIC AND TAXONOMIC NOTES. Proc. Academy of Natural Sciences of Philadelphia, Vol. CVI, pp. 109-164.

This paper presents information on the occurrence and distribution of fishes in one of the lesser streams, the Escambia River. The basis for subspecific de-

limitation among those Escambia River fishes that are usually treated as polytypic have been reassessed. Salinity tolerances and seasonal movements of fishes in the tidal section of the river are discussed. The zoogeographic position of the basin is discussed in relation to the other east gulf drainages, so far as these are known ichthyologically.

146. Trama, Francesco B. 1954. THE ACUTE TOXICITY OF SOME COMMON SALTS OF SODIUM, POTASSIUM AND CALCIUM TO THE COMMON BLUEGILL. Proc. Academy of Natural Sciences of Philadelphia, Vol. CVI, pp. 185-205.

A brief account of past work dealing with the toxicity of the nine salts used in these experiments is given. The sodium, potassium, and calcium salts of chloride, sulfate, and nitrate were tested under the same experimental conditions and their toxic properties evaluated.

A soft synthetic dilution water was used in all these experiments and the common bluegill, Lepomis macrochirus Raf., was the test organism.

The relative toxicity of the various salts was: $NaCl<NaNO_3<CaCl_2<Na_2SO_4<Ca(NO_3)_2<KNO_3<KCl<K_2SO_4$. The relative toxicity of the cations was $Na<Ca<K$. The relative toxicity of the anions, based on the experiments with the sodium salts, was $Cl<NO_3<SO_4$. (A)

147. Mohanty, G. B. and A. B. Roy. 1954. HYDROLYZED FISH PROTEIN FROM THE FLESH OF WASTE FISH. Science, Vol. 121, No. 3132, Jan. 7, pp. 41-42.

A brief article describing a procedure for extracting cheap protein from the flesh of sharks and rays. The finished product has an 85-percent protein content, is easily soluble in water, the keeping quality in powder form is good, and the whipping power is greater than that of egg albumen.

148. Gajdusek, D. Carleton. 1954. TARAHUMARA INDIAN PISCICIDE: GILIA MACOMBII TORREY. Science, Vol. 120, No. 3115, Sept. 10, p. 436.

A piscicide, Gilia macombii, used by the Tarahumara Indians and not previously reported, was used in experiments with gold fish. Results showed that a filtered, cold aqueous extract made from powdered dried plant in a concentration of 1.0 mg/ml is sufficient to stun the fish in 10 minutes and to kill them in less than 50 minutes. Plants dried at room temperature for three months were used.

149. Blum, John L. 1954. EVIDENCE FOR A DIURNAL PULSE IN STREAM PHYTOPLANKTON. Science, Vol. 119, No. 3099, May 21, pp. 732-734.

During 1952 and much of 1953, the algae of the Saline River in southeastern Michigan were under close observation. The Saline is a small stream located in Washtenaw County about 7 miles south of Ann Arbor, that is polluted by both domestic and industrial wastes. In the summer of both these years, this stream exhibited in its polluted portion a region about 4 km. in length that was dominated by the benthic diatom Nitzschia palea (Kutz.) W. Smith growth in a conspicuous brown sheet or layer on submerged rocks or silt deposits. Filamentous algae were abundant at certain seasons, but at the time and place of the work reported they did not represent a significant element of the plankton or an important vehicle for the transport of entrapped or epiphytic organisms.

A very dense net plankton composed almost entirely of N. palea can be collected from this stream in the summer months but only in and immediately below the course of the river within which N. palea is abundant as a bottom organism. This appeared to be a favorable situation in which to find a diurnal variation in stream plankton. Two locations were accordingly chosen for making comparative observations at different hours of the day. At each point, the net plankton was sampled at dawn and in late afternoon of August 13, 1953. Counts of this material showed that planktonic N. palea was much more abundant at both stations in the afternoon than at dawn.

In an effort to demonstrate a diurnal periodicity more clearly, plankton samples were then taken at approximately hourly intervals throughout a 24-hour period on August 25 and 26, 1953. Results clearly showed that N. palea entered the plankton in quantity in late morning. Its numbers fell off sharply in midafternoon, and during late afternoon and evening a slow return to the nocturnal minimum took place.

As factors in the diurnal periodicity exhibited by Nitzschia palea, both water temperature and water level can very likely be ruled out, since neither varied significantly in such a way that its variations could be correlated with changes in the phytoplankton.

150. Wright, John C. 1954. THE HYDROBIOLOGY OF ATWOOD LAKE, A FLOOD-CONTROL RESERVOIR. Ecology, Vol. 35, No. 3, July, pp. 305-316.

A two-year study (1947-1949) was made of the physical, chemical and biological characteristics of Atwood Lake, a flood control reservoir in eastern Ohio, with special reference to the effect of these factors on the production of desirable crops of game fish. Previously, the lake was drained to get rid of rough fish thought to be creating conditions unfavorable for game and pan fish.

Poor light penetration in the upper end of the lake was due largely to the presence of iron-humus colloids. Turbidity was important only during the spring months as a result of surface runoff.

Phytoplankton crops were extremely low in comparison to more productive lakes. Phytoplankton numbers were greater in 1949 than in 1948.

Zooplankton populations were greater in the upper end of the lake where a large amount of vegetation was inundated by the rise in water level of the lake in 1947. Zooplankton crops were smaller in 1949 compared to 1948; the greatest decline occurred in the upper end of the lake.

Bottom fauna was very low, which was correlated with low phytoplankton production.

The fish population consisted mainly of black and white crappie in very poor condition, stunted bluegill, such rough fish as carp, gizzard shad, and a small population of largemouth bass. The bass was

the only game fish that grew at a satisfactory rate. Black and white crappies and bluegills grew at satisfactory rates the first year following drainage and at very low rates the second year. Declining zooplankton and a paucity of bottom fauna were suggested as the cause of the slower growth rates subsequent to the first year. The satisfactory growth rate of largemouth bass was attributed to the abundance of undersized fish upon which the bass could prey.

No evidence was obtained to show that carp were affecting the productivity of the lake. It was concluded that the natural level of productivity of Atwood Lake was too low to maintain satisfactory growth rates of the populations of game fish produced following drainage.

151. Wohlschlag, Donald E. 1954. MORTALITY RATES OF WHITEFISH IN AN ARCTIC LAKE. Ecology, Vol. 35, No. 3, July, pp. 388-396.

In unexploited Ikroavik Lake near Point Barrow, Alaska, summertime mortality rates of Leucichthys sardinella and Coregonus nasus were determined by mark-and-recapture methods described by Leslie and Chitty (1951) and Bailey (1951). The application of these techniques is discussed in detail and it is concluded that they are feasible if sampling can be carried out on a sufficiently large scale, particularly in conjunction with other studies involving mark-and-recapture operations.

Catch-curve data suggest that the older L. sardinella die at greater rates than do middle-aged fish. All available evidence indicates that the L. sardinella die at greater rates during the summer than during the remainder of the year when the population is confined to very little water under a thick ice cover.

152. Ketchum, Bostwick H. 1954. RELATION BETWEEN CIRCULATION AND PLANKTONIC POPULATIONS IN ESTUARIES. Ecology, Vol. 35, No. 2, April, pp. 191-200.

The rate at which a planktonic population must reproduce in order to maintain itself in an estuary is determined by the vigor of the circulation. The reproduction rate required for an endemic population is defined in terms of an exchange ratio determined as the proportion of water escaping seaward each tidal cycle.

If a population is augmented from upstream as well as depleted by the circulation, a steady-state population will be achieved at a level determined by the rate of reproduction and the rate of the circulation. A method for determining the size of the population expected under various conditions is presented.

Examples of the application of these calculations in various estuaries are presented for a bacterial population, a phytoplankton population, the planktonic larvae of a sedentary population, and larvae of a zooplankton population. (A)

153. Jackson, Daniel F. and James McFadden. 1954. PHYTOPLANKTON PHOTOSYNTHESIS IN SANCTUARY LAKE, PYMATUNING RESERVOIR. Ecology Vol. 35, No. 1, January, pp. 1-4.

In this study, photosynthesis and respiration rates of phytoplankton were measured by pH change produced by absorption or evolution of carbon dioxide in water samples from Sanctuary Lake. The abundant phytoplankton population in Sanctuary Lake permitted comparable photosynthetic measurements of both the phytoplankton enclosed in bottles suspended in the lake and the identical population occuring simultaneously under natural conditions.

The two methods showed close agreement: 1.00μ moles CO_2 absorbed per mg. ash-free dry weight per hour, under strictly natural conditions; 1.34μ moles CO_2 when samples were enclosed in bottles. Respiration rates averaged approximately one-half the total photosynthetic rate, but respiration rates between midnight and noon were significantly lower than rates observed between noon and midnight. (A)

154. Gerking, Shelby D. 1954. THE FOOD TURNOVER OF A BLUEGILL POPULATION. Ecology, Vol. 35, No. 4, October, pp. 490-498.

The food turnover of the bluegill (Lepomis macrochirus) population of Gordy Lake, Indiana, was estimated by emphasizing the role of protein in the nutrition of fishes. Protein turnover is defined as the amount of protein that is required by a population for growth, for the metabolic expenditure of energy, and for the replacement of proteins broken down during the normal course of living. The efficiency of protein utilization for growth was determined by experiments on bluegills in the laboratory. Field studies provided information about the vital statistics of the Gordy Lake population. The protein turnover was computed by combining measurements of protein utilization, growth, mortality and the population of bluegills in the lake.

It was estimated that about 156.8 kg. of protein were consumed by the bluegill population in 1950. About 47.9 kg. of protein were added to the population in growth, and the remainder (108.9 kg.) was used for the metabolic expenditure of energy.

It was estimated that the total amount of food organisms consumed by the bluegill population was 1635.0 kg. or 142 kg. per hectare (126 pounds per acre).

Under the observed conditions of mortality and growth, recruitment must replace about one-half the average standing crop per year.

155. Verduin, Jacob. 1954. PHYTOPLANKTON AND TURBIDITY IN WESTERN LAKE ERIE. Ecology, Vol. 35, No. 4, October, pp. 550-561.

The highest phytoplankton crop observed in western Lake Erie between September 1938, and September 1953, was the spring crop of 1949 (16 mm.^{3}/1.). That crop was associated with transparencies permitting 1% of surface light to penetrate to 4.8 m. Only during one season in the period of study were large areas encountered exhibiting turbidities so high (1% of surface light at 3.5 m.) that they could be supposed to exert a major controlling influence on phytoplankton growth. The low spring crops of 1951-52-53 (1-2 mm.^{3}/1.) were associated with

transparencies permitting 1% of surface light to penetrate to 6.6, 5.4, and 7.2 m. respectively.

Maps are presented showing the horizontal distribution of turbidities in an area comprising about half of western Lake Erie.

A graph of phytoplankton crops against the depth associated with 1% of surface light, constructed from data obtained during the spring of 1950, showed that the highest crops arose in waters of intermediate turbidity.

The effectiveness of light-quenching by suspended particles in waters of the Bass Islands region has been determined by computing the value of k in an equation ($k=4.6/d'c$) derived from the Lambert-Beer's Law using experimental determinations of the depth (d') associated with 1% of surface light, and the concentration (c) of suspended matter in the water. Values of k, in 35 samples ranged from 0.10 to 0.20, when d' was expressed in meters and c in mg./l. (oven-dry). Of the 35 samples, 27 showed k values between 0.11 and 0.15.

A table of maximal phytoplankton crops from various habitats is presented, showing that the upper limits occurring in shallow habitats (1.5 m.) appear to be of the order of 100 mm.^{3}/l.

156. Dales, Samuel and William S. Hoar. 1954. EFFECTS OF THYROXINE AND THIOUREA ON THE EARLY DEVELOPMENT OF CHUM SALMON (ONCORHYNCHUS KETA). Can. J. of Zoology, Vol. 32, No. 3, June, pp. 244-251.

Eggs of chum salmon were incubated in solution of synthetic thyroxine sodium or thiourea. Thyroxine accelerated growth of the body wall and pectoral fins but reduced the rate of increase in body length. In addition, thyroxine treatment produced exophthalmia, intense deposition of guanine, and decreased pigmentation. Thiourea likewise reduced the rate of growth in length but had no apparent effect on the development of body wall or fins. Decreased deposition of guanine was evident in thiourea treated fish but the deposition of melanin was not affected. Thyroids of fish treated with thyroxine showed characteristic colloid storage while those of fish in thiourea were hyperplastic. The rate of contraction of the embryonic heart was unaffected by the treatments. (A)

157. Gibson, E. S. and F. E. J. Fry. 1954. THE PERFORMANCE OF THE LAKE TROUT, SALVELINUS NAMAYCUSH, AT VARIOUS LEVELS OF TEMPERATURE AND OXYGEN PRESSURE. Can. J. of Zoology, Vol. 32, No. 3, June, pp. 252-260.

The ultimate upper lethal temperature is estimated to be 23.5° C. The temperature for maximum activity is from 15° C. –17° C. Active respiration becomes dependent on the oxygen pressure at approximately two-thirds air saturation. The minimum oxygen pressure for this species is approximately 40 mm. Hg at 20° C. and 60 mm. Hg at 20° C. These data pertain to one- and two-year fish. (A)

158. Choquette, L. P. E. 1954. A NOTE ON THE INTERMEDIATE HOSTS OF THE TREMATODE, CREPIDOSTOMUM COOPERI HOPKINS, 1931, PARASITIC IN SPECKLED TROUT (SALVELINUS FONTINALIS (MITCHILL)) IN SOME LAKES AND RIVERS OF THE QUEBEC LAURENTIDE PARK. Can. J. of Zoology, Vol. 32, No. 6, December, pp. 375-377.

In some areas of the Quebec Laurentide Park the developing larval stages of the trematode Crepidostomum cooperi were found in sphaeriid clams of the genus Pisidium (P. subtruncatum, P. compressum, P. adbitum, P. llijeborgi, and P. mitidum), and the encysted state in nymphs of the mayfly Hexagenia recurvata and in those of another species of mayfly of the genus Polymitarcys. These constitute new records of intermediate hosts for C. cooperi. Sexually mature worms were recovered from trout three to four weeks after the trout fed upon infected mayfly nymphs, thus confirming Hopkins' observation on the length of time required by the worm to attain sexual maturity. (A)

159. Gibson, M. Beatrice. 1954. UPPER LETHAL TEMPERATURE RELATIONS OF THE GUPPY, LEBISTES RETICULATUS. Can. J. of Zoology, Vol. 32, No. 6, December, pp. 393-407.

Guppies, Lebistes reticulatus, of inbred and unselected stocks, were tested for their variability in resistance to upper lethal temperatures. Unselected fish were maintained in constant temperatures of 20°, 25°, and 30° C. from birth and were subjected to lethal temperatures either without further treatment or acclimated to 30° C. before testing. Inbred lines were reared at 25° C. and acclimated to 30° C. Resistance times were determined at constant temperatures ranging from 33° to 38° C. Acclimation has a moderate influence on the resistance times at the higher lethal temperatures, but the effect is lessened at 35° C. and disappears at 34° C. There is an indication of an optimum rearing temperature in the neighborhood of 25° C. for resistance to the higher temperatures. General response to high lethal temperatures is similar to that reported for other fish, but heterogeneity is exhibited at 37° and 34° C. Both genetic composition and early thermal history influence resistance to high temperatures as well as acclimation just prior to experiment. The upper incipient lethal temperature is slightly above 32° C. over the biokinetic range of the guppy. (A)

160. Winn, Howard Elliott and Robert Rush Miller. 1954. NATIVE POSTLARVAL FISHES OF THE LOWER COLORADO RIVER BASIN, WITH A KEY TO THEIR IDENTIFICATION. Calif. Fish and Game, Vol. 40, No. 3, July, pp. 273-285.

It is frequently important that biologists be able to identify correctly the eggs and young stages of fishes. This is often necessary for the solution of such problems as the location of breeding sites, the distribution and biology of the larvae, and the conservation of populations. The abundance of a year class may be determined by the environmental conditions that act on the critical larval periods. The species treated in this paper belong to two families, the Catostomidae (suckers) and Cyprinidae (minnows). There are accompanying photographs.

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